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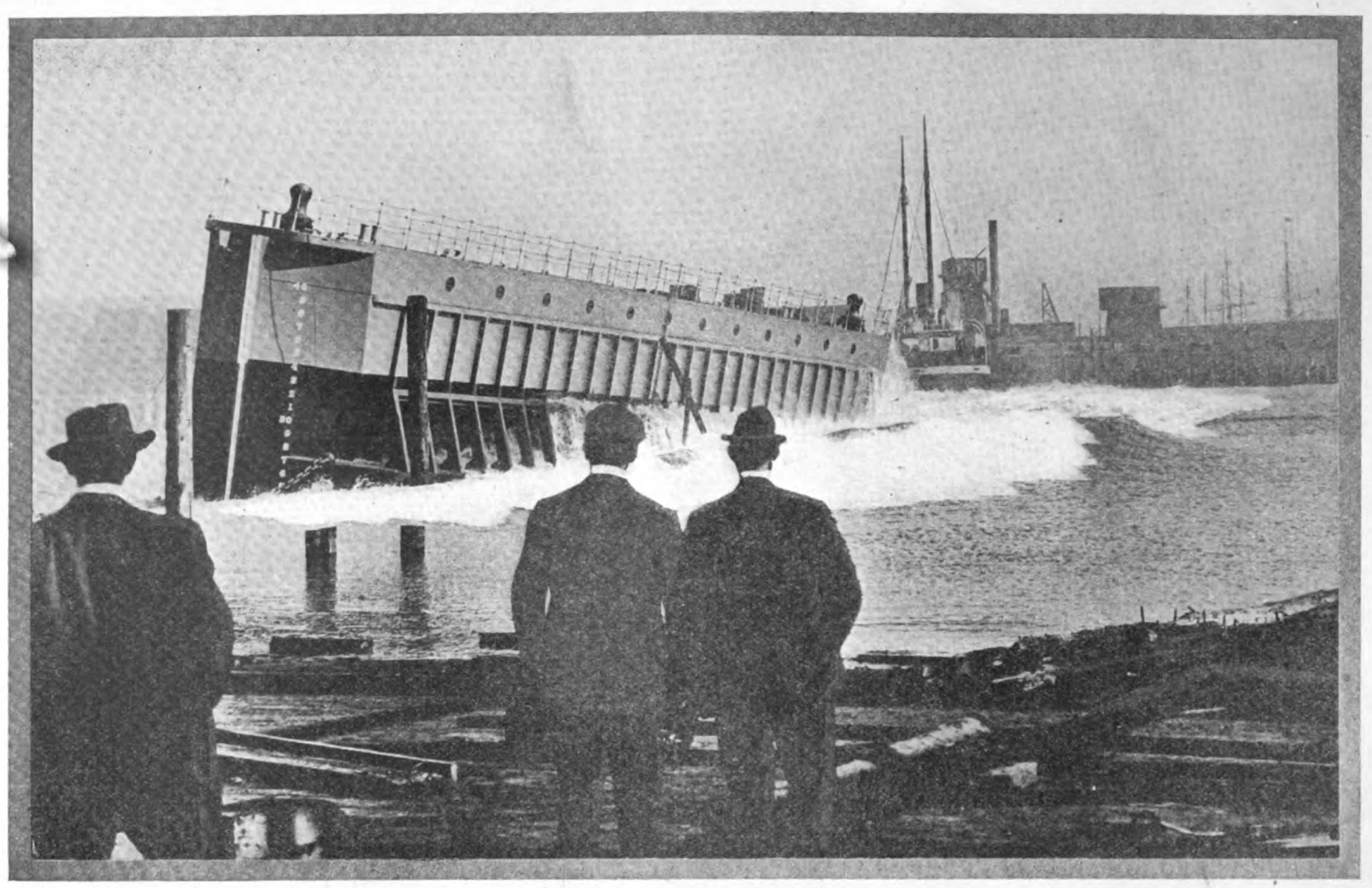

LAUNCHING THE CAISSON FOR THE PEARL HARBOR DRY DOCK, WHERE AMERICA'S BATTLESHIPS ARE TO BE CARED FOR IN MID-PACIFIC.

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EDITORIAL

'FREE as the air' has been a trite saying for many generations, and one that people have clung to with increasing fervor as the other necessaries of life gradually became promoted, capitalized, duly admixed with H_2O, and made to pay dividends for the purchase of ducal coronets and other luxuries. It seems, however, that even air, the last essential of existence of human life, must now take its place with water, light, and food, as the farmers whose lands surround the aerodome of Maurice Farman at Buc, France, have brought an action in the French courts to prohibit him from flying at a height less than 656 feet, and have asked for a heavy compensation for the disturbance caused by the frequent passage of aeroplanes over their ground.

THE recent shortage of coal at the Canal Zone brings out the fact that the Panama railroad alone consumes nearly 30,000 tons of coal per month, all of which is shipped from the Atlantic seaboard. Labor troubles at the mines are given as the cause of the shortage. The steamer *San Jose*, of the Pacific Mail Steamship Company, was delayed ten days last month by reason of its inability to obtain coal from the Government as has been the custom. Had California oil been the fuel in use, such a shortage would have been impossible, the conditions governing the production of oil being such that labor troubles are a negligible factor in every particular, except possibly during transportation. The large overproduction of oil at present and the slowness with which consumption is catching up with supply should stimulate action on the part of California oil producers toward inducing the Panama railroad officials to substitute oil for coal.

CREDITS based upon contractors' costs is the subject of an interesting paper by William H. Nye appearing in the *Banker and Investor Magazine*, an abstract of which appears in THE ENGINEERING DIGEST. Mr. Nye's analysis of the financial condition of the contractor is interesting to the people of the West, particularly in San Francisco, where failures due to inability to finance contracts are sufficiently frequent to excite little comment. It is needless to discuss the actual damage and loss that falls upon the careful and conservative contractor who is subjected to careless and irresponsible competition when bidding for work, and it is small consolation that he may comfort himself with the assurance that excessively low bids generally indicate an addition to the year's quota of bankrupts and a bank manager with a loss to explain to his board of directors. Engineering contracting nowadays is not only a business, but a profession, and should be recognized and treated as such. The financing of engineering contracts is a profitable line of business for banks, and should be attended by no more risk than loans on any other legitimate commercial enterprise. When, however, banks lend money on the mere representation of an irresponsible or inexperienced contractor, without ex-

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pert advice from a competent engineer, it is not surprising that much money is lost and that responsible and conservative contractors frequently find it difficult to finance their construction work. The banker who would not make a business move of the most trivial nature without consulting his attorney, has been known to lend money on engineering contracts without the slightest technical advice as to the reliability of the cost estimate submitted to him by the contractor. It is quite as necessary that a bank dealing with engineering contractors should have a consulting engineer on its staff to pass upon the reliability of cost estimates submitted as a basis for a loan, as that it should have an attorney to pass upon the legal points involved. If this were done, every careful and conservative contractor could readily finance his contracts and the banks would open up a profitable line of business that is now looked upon with disfavor if not suspicion.

San Francisco Wharves

HASTY condensation of material for our news columns last month led to a couple of errors in regard to the work of the Board of State Harbor Commissioners. In the space north of pier No. 34, four new wharves are to be built. Of these, No. 30 and No. 32 will be occupied by the American-Hawaiian Steamship Company, No. 28 by the Matson Navigation Company, and No. 26 by the California & Atlantic Steamship Company (Bates & Chesebrough, agents). The plans for all of these have been prepared under direction of Mr. A. V. Saph, Assistant State Engineer, who is Chief Engineer for the Board. On all four wharves, in accordance with its usual custom, the Board has endeavored to comply with the ideas and desires of the prospective tenants to the fullest extent. Three of the wharves, 26, 30, and 32, are to be fitted with mechanical conveniences for handling freight, and the details of these arrangements have been handled by Mr. Leland S. Rosener, who is engineer for the companies rather than the Board, as might have been inferred from our statement. The Board has provided for all necessary rails for cranes, ship-towers, and telphers, and has given the necessary clearances, but the contracts for the piers do not include the telphers and ship-towers. Final details regarding freight handling on the piers occupied by the American-Hawaiian Steamship Company will soon be passed upon by Mr. George Shepard, the superintendent for the company. In the meantime bids for piers 30 and 32 were received April 25, going to Robert Wakefield at $975,981, which does not include cement, paving, or steel doors. Plans for piers 26 and 28 were approved April 23 by the Advisory Board of the State Department of Engineering, and when final blueprints and specifications are prepared, will be advertised for bids to be opened June 1. Pier 17 is under construction, and plans are being prepared for four new wharves on the northern front. Bids for the two new ferry slips have not yet been asked. These slips will be constructed at the same time as are the buildings, designs for which are now in the hands of the architects, the L. B. Dutton Company. Within a short time $2,000,000 worth of construction work on the San Francisco waterfront will be under way, with more to follow as rapidly as it can be economically handled. In the race to provide superior docking facilities, San Francisco will therefore be well to the front.

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The Santa Barbara Tunnel

AMONG the minor disasters of the month was a bad cave-in at the Santa Barbara water tunnel, which was at first reported to threaten the success of the whole work. Fortunately no lives were sacrificed, and while serious loss and delay will result, the damage is far from irreparable. The city of Santa Barbara, being confronted with a water shortage, set about to acquire an additional supply. The Santa Ynez range of mountains intervenes between the city and the Santa Ynez river, where the flood run-off from 220 square miles may be impounded in a large reservoir-site. The range itself is a sharp and faulted anticlinal fold, the formation consisting of shale and sandstone. The sandstone predominates on the southern slope and the shales on the northern. The length of the tunnel through the range to reach the river is 19,600 feet. About 6000 feet has been driven from the northern or upper end of the tunnel and about 12,800 feet from the south. The dip of the rock is fully 80 degrees, and the tunnel is nearly at right angles to both the dip and the strike. If a book were placed on its long edge, slightly opened, and a pencil thrust through it at right angles, it would represent graphically the physical characteristics encountered in driving the tunnel. Both sulphurous and hydrocarbon gases were found in the north end, and they were of a highly explosive character. The work at the upper end was suspended 6000 feet from the portal because the water entering the tunnel reached 550,000 gallons per day, which was in excess of the capacity of the pumps. At the south end the tunnel had been driven fully as far at that time, and as the water flowed out from this end by gravity, it was decided to complete the tunnel from this lower end.

The crest of the mountain rises 1600 feet above the grade of the tunnel, and the water filling the interstices between the strata has enormous pressure, sometimes blowing-in the working face of the tunnel, and in a few instances blowing the machine drills out of the drill-holes and bending the steel. These strata drain when opened, but the flow from the lower, or south, end of the tunnel has been sustained at from 5,000,000 to 6,000,000 gallons per day for the past two years. The tunnel is 6 feet wide and 7 feet high, which is larger than would be required for the conduct of the water, but it is found to be too small, either for comfort or the most rapid construction work, on account of the water which has developed. The work of excavation has been stopped several times in order to line with concrete portions that have appeared insecure, and 45 per cent of the tunnel is now concreted. Pending the concreting, the tunnel has been timbered in the portions where the ground is heavy, and the timbering was constantly and carefully inspected. Every precaution had been adopted.

Only 780 feet of the tunnel remained to be driven at the time of the accident, and the work was progressing at the rate of 15 feet per day in fair ground. During the past month heavy rains have occurred, and the strata which were previously drained have, in part, been recharged from the surface. At a point 7300 feet from the south portal, where a stratum of broken shale 10 feet thick was passed and was timbered, a hydrostatic pressure was established, possibly entirely above the tunnel grade, which suddenly crowded the shale against the timbers,

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and this caused the cave-in. The men working in the tunnel had barely time to get out before the tunnel was blocked with débris and timbers. About 4,000,000 gallons of water per day entered between the heading and the cave, and as this quickly filled the tunnel, the pressures began accumulating. The high-pressure air-pipe that remained intact under the broken rock showed a static head of 140 pounds, before it broke under the pile five days after the cave. This high pressure accumulated until it blew out the pile of broken rock several times and made work in the tunnel dangerous. Apparently the material has now reached an equilibrium, and a heavy wooden bulkhead 24 inches thick has been built across the tunnel at a place where there is a massive sandstone ledge. A space of one foot is left on top, so that a hydrostatic pressure may not accumulate. This bulkhead is 500 feet from the cave. A reinforced-concrete bulkhead 10 feet thick has been built immediately back of the wooden one, in order to further guard against the heavy water-pressure pushing the mass of rock and mud down the tunnel. These bulkheads are holding the pile, and it is believed that they will stop the further filling of the tunnel. The débris can not travel toward the heading because of the hydrostatic pressure on that side.

It has been recommended to the Water Commissioners that the caved material be left undisturbed, and that a new tunnel be driven around the cave-in. As laid out, this line would start at a point about 500 feet from the cave, pass 100 feet west of the centre line of the old tunnel and return to the latter about 300 feet beyond the cave. The turn-out and the return would both be in solid sandstone. It is believed that the high pressure in the main tunnel back of the débris will largely relieve itself through the rock fissures into the new piece of tunnel, and that the return can be made into the old tunnel through the sandstone in safety by driving pilot drill-holes about 20 feet long ahead of the working face as the old opening is approached. If the effort is made to clean out the fallen material, it is certain that as soon as the outer slope is removed, the movement of the mass will again start toward the portal of the tunnel, because of the high pressure in the rear. The new piece of tunnel around the cave, in all probability, will be much cheaper to drive than would be the cleaning out of the old pile, and it would also be very much safer. The plan of running around the obstruction was adopted successfully in recovering the Ontario drainage tunnel in the Park City, Utah, district and has also been employed elsewhere. When solid rock in which to drive is available it affords a simple way to meet the difficulty.

Mr. J. B. Lippincott, to whom we are indebted for notes on the work, has been connected with the driving of about 130 tunnels, and he states that the obstacles encountered here have been greater than on any other tunnel in which he has worked. He calls especial and deserved attention to the bravery of the miners in building the bulkhead. Mr. Lee Hyde has been engineer in charge of the tunnel since the work started, and Mr. Lippincott has been consulting engineer on the work for the same length of time. The newspaper accounts of the cave-in have been of an alarming nature, not justified by the facts. The condition has been serious, but not more than 800 feet of the tunnel will be lost.

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REVIEW OF THE MONTH

DISASTER and sudden death loom large in the foreground, in reviewing the events of the month. The loss of the *Titanic* and the appalling sacrifice of human life overshadows all other events. A cyclone swept across Illinois, and floods in the Mississippi have added their list of dead and of unfortunates who must face the destruction of their homes and means of making their livelihood. The Drainage Congress at New Orleans passed resolutions asking the Government to appropriate $1,000,000 annually until the completion of the Panama canal, and $50,000,000 per year thereafter for land reclamation and flood control. In THE ENGINEERING DIGEST this month we give details of a bill introduced in the Senate at Washington by Mr. F. G. Newlands and designed to meet this situation, and last month we discussed the problem of flood control in the Sacramento valley, emphasizing the folly of permitting such conditions to recur year after year with their attendant loss of life and property. The problem is too big to be solved without Federal aid, and whether or not it be wise at this time to attempt so elaborate a program as has been outlined, there can be no question but that it is time to substitute a comprehensive plan and orderly progress for the present piece-meal legislation.

THE *Titanic* disaster has filled the whole civilized world with horror and brought sorrow and mourning into the homes of hundreds of people. The great increase in size of ocean-going vessels and their luxurious appointments have caused them to be justly termed 'floating palaces.' Creature comforts have received first consideration at the hands of the designers, and even the finest hotels ashore can not boast of the innumerable means of recreation and amusement that were provided on the *Titanic* and other vessels of her class. Swimming tanks, tennis courts, roof gardens, passenger elevators, a theatre for amateur entertainments, and countless minor features make the transatlantic voyage of today the acme of luxury, and afford men and women of means a delightful opportunity for relaxation from the cares and duties of business and social life while enjoying to the full everything that goes to make life on board a modern Atlantic liner one of Sybaritic ease. Speed is, of course, provided, as no trait in the character of the twentieth century man is more pronounced than the frantic desire to go faster—witness the eagerness with which people pay excess fare in order to travel on the 18-hour trains from New York to Chicago; the crowds that flock to see a man risk, and often sacrifice, his life in driving an automobile a mile in 40 seconds.

The keen rivalry that exists between the many lines competing for transatlantic traffic, and the knowledge that by speed alone the White Star company could maintain supremacy on the seas, is undoubtedly the reason why a speed of 21½ knots per hour was maintained and the acknowledged warnings of the presence of icebergs ignored. The possibility of accidents seems to

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have been entirely disregarded, the long immunity therefrom and belief in the 'unsinkable' character of the ship apparently producing a feeling of security that resulted in sacrificing the lives of the passengers to speed and luxury of appointments. When the crash came, and the vessel was seen to be sinking, it was found that but twenty boats and a few rafts were provided for a steamer whose complement of passengers and crew exceeded 2500 people. It is still more unbelievable, but true nevertheless, that the letter of the British laws governing shipping permit this condition to exist, as they provide a schedule of lifeboat equipment for vessels up to 10,000 tons, and then specify for vessels "10,000 tons and *upward*, minimum 16 boats, having a cubic content of not less than 5500 cubic feet." Ten cubic feet per passenger is allowed, so the *Titanic*, a steamer of 45,000 tons displacement, equipped with only four more than the number of lifeboats specified by the English law, was able to provide in case of wreck for the safety of 687 persons. It is stated that the *Titanic* was equipped with davits for 80 lifeboats, but as the swimming tanks, tennis courts, and roof gardens were undoubtedly expensive and heavy, the White Star company evidently saw no necessity for more than complying with a law that was framed in a day when a 10,000-ton vessel was a monstrosity; a law which apparently has been allowed to rest under the dust of the ages, unthought of and unchanged.

The American laws governing shipping, which are considered to be inferior to the English in many respects, provide for lifeboats having a total of 7920 cubic feet (792 persons) for a 10,000-ton vessel; 12,420 cubic feet (1242 persons) for a 20,000-ton vessel, and 225 cubic feet additional for each 500 tons increase. Had the *Titanic* been an American bottom, she would not have been permitted to sail without being equipped with lifeboats having an aggregate capacity of 23,670 cubic feet, sufficient for 2367 persons. A thorough inquiry is now being conducted by Congress in an effort to fix responsibility for the terrible loss of life, and there is no doubt that changes and revisions in existing laws will result, and that the danger of a recurrence of such a condition will be impossible in the future. The National Marine Association has asked the Foreign Office in Berlin to call for an international conference to draft regulations regarding the life-saving equipment of ocean-going vessels, so the hundreds of brave men and women who went to their deaths in a calm sea under a clear, starlit sky may not have sacrificed their lives in vain.

RAILWAY wages have shown a substantial increase during the fiscal year 1911. Reports filed with the Interstate Commerce Commission show that the total compensation to the employees of railways over 500 miles long was $1,005 277,249. The total wage cost to the railways for the year was greater by $41,868,822 than it would have been at the rates of pay in effect during 1910, and greater by $69,297,678 than it would have been at the rates of pay in effect during 1909. Notwithstanding an increase of 2108 miles of railway operated, there were fewer employees on the payrolls June 30, 1911, than on June 30, 1910, by 31,037, yet the total compensation paid to employees during 1911 was greater than that paid during 1910 by $49,976,216. This is greater than the increase in the gross earnings of the railways by $22,-

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595,121. The net revenues of the railways, which are what is left after paying operating expenses, fell off by $40,988,539 during this same period in which compensation increased nearly fifty million dollars.

NOT all the events of the month, fortunately, were of the same gloomy character as will be seen on reading our news summary. Excellent reports come from Panama, good work is being done on the Exposition grounds, and a surprising number of new steamers is being built.

IMPROVEMENT in Pacific Coast business conditions is manifest in the records of the San Francisco Custom House for March showing 2433 import entries, making the best record in the history of the import trade. Customs authorities expect business of this department to double immediately after the opening of the Panama canal.

RE-ESTABLISHMENT of an American line of steamers from San Francisco to Sydney, Australia, has been planned for some months, and it is now announced that the first boat will leave San Francisco July 2. The run will be made in 19 days with stops at Honolulu and Tutuila, and steamers will be dispatched every 28 days thereafter. The *Sonoma* and *Ventura* have been rebuilt by the Oceanic Steamship Company for this service.

PACIFIC COAST steamer passenger traffic has shown a gratifying increase for the calendar year 1911, according to figures filed in the office of Mr. John K. Bulger, Supervising Inspector of Steam Vessels. The figures given are: Pacific Coast Steamship Company, 137,626; Pacific Navigation Company, 109,943; San Francisco & Portland Steamship Company, 55,773; North Pacific Steamship Company, 32,822; Charles H. Higgins, 5163; Charles R. McCormick, 4061; E. J. Dodge Company, 3607; Pollard Steamship Company, 3210; Interocean Transportation Company, 2129; Swayne & Hoyt, 1907; J. R. Hanify & Co., 1585; California & Oregon Coast Steamship Company, 1513; A. F. Estabrook Company, 1291. Figures for the Catalina Island service were: Wilmington Transportation Company, 215,005; Meteor Boat Company, 63,733.

THE launching of the caisson for dry dock No. 1, U. S. Naval Station, Pearl Harbor, Hawaii, which took place at the Union Iron Works, San Francisco, Friday, April 12, forms the subject of our frontispiece this month. The caisson is of the hydrometer type, the general dimensions being: length at upper deck 126 feet 4½ inches, width 15 feet, width of stringers at offset 20 feet, height to top of frames at side 43 feet 6 inches, gross tonnage 483, draft, including 300 tons of concrete ballast, 24 feet 6 inches. Ten 30-inch culvert valves and two 20-inch seating valves, all of the rising-spindle direct motor-driven type, are used for filling the caisson, while two vertical centrifugal direct motor-driven pumps are used for emptying, which operation can be accomplished in ten minutes. There are two electrically operated capstans for moving the caisson to one side to permit the ingress and egress of vessels. The caisson left for Pearl Harbor, Hawaii, the day after launching, in tow of the tug *Hercules*, and will there form a link in the chain of docking facilities that the Government is providing for vessels between San Francisco and the Far East.

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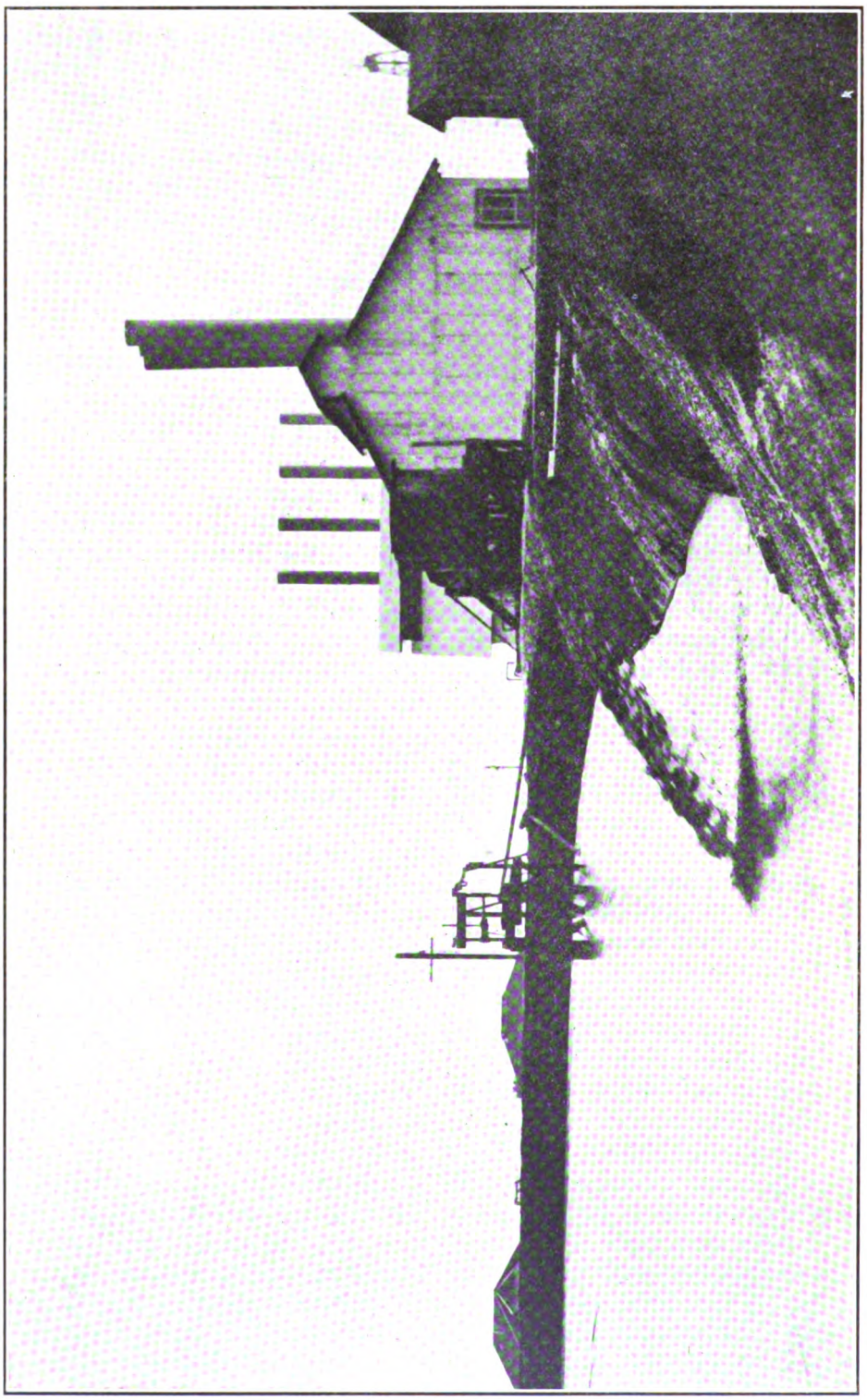

FILLING AN OIL RESERVOIR IN THE M'KITTRICK FIELD.

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Oil Well Pumping Methods

By THOMAS COX*

STEAM-POWER is the most common method used for pumping and operating in the California fields, the usual custom being to place from two to four 40 or 50-hp. boilers at a central plant for two or three wells, laying a steam line to the engines that have already been used for drilling the wells. These steam lines are laid in the ground, sometimes with a covering of oil sand, and often merely buried in the surface soil. Some of the larger companies have central boiler plants and pipe to several wells, covering the steam lines with asbestos, although this is not often done. Crude oil is the fuel commonly used, although in some cases gas is piped to the boilers. This is exceptional, as in California it is not often that a lease yields sufficient gas to burn for all its steam requirements. The steam-engine is conceded to be reliable, and furnishes the most flexible power for pulling or bailing a well, the general method of operating being to employ small plants for two or three wells. Such an arrangement only permits a pumper to attend to the boilers and to watch two, or occasionally three, wells. Boiler waters in the oilfields are generally hard, and deposit heavy scale in the boilers which makes repairs and upkeep costly; the labor and operating charges are consequently high.

Pumping and operating, after drilling, may be done by means of electric motors, compressed air, internal-combustion, gasoline, crude oil, or natural-gas engines, the local conditions at each lease determining which method is cheapest and most suitable. On a lease with no natural gas it would not be wise to use gas-engines, while on one having an ample supply of natural gas, the purchase of high-priced electric power, or the building of an expensive central plant would not be justified.

Pumping by electric motors is a clean economical method of operating, especially where power can be obtained cheaply. It permits of one attendant taking care of a large number of wells. A central plant furnishing compressed air and distributing it to various well engines, involves making a large investment, and is not an economical method of operating this class of engines.

Using compressed air direct in the wells for air-lifts depends for successful operation upon the depth of the well and the water conditions. It is effective where a large percentage of water is present with the oil and the wells are not so deep as to require a high working-pressure. Deep sandy wells having no water may not be successfully worked with direct air, as the latter, if applied so as to give continuous operation, exhausts its head and

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blows through, appearing to produce a freezing and repressing effect on the oil in the well. The production in trials made in a 2900-ft. well was much less than with a 3-in. pump on the beam. Applying air under pressure intermittently, exhausting after allowing the oil to raise to its level, caused the sand to run in and choke the pipes at each trial. The starting pressure required was from 1400 to 1500 lb. per square inch; this, after the start, was reduced to about 750 lb. The cost of compressing air to such a pressure would make the cost of pumping excessive. This form of air-lift is successful and beneficial in territory having wells less than 2000 ft. in depth, where water is encountered with the oil, and when the oil is free from shale or sand. Engines using crude oil of 14° gravity do not appear to be available, as no guarantees are obtainable for performance with this low-gravity oil.

The following is a comparison of the various schemes for operating wells, based on an investment for equipment necessary to operate 50 wells, pumping 100 bbl. per day per well. Steam-plants using fuel oil, and placed between each two wells, with two pump attendants to each two wells, are considered as 'unity' for purposes of comparison. When natural gas is specified it is assumed, for the purpose of the comparison, that an adequate supply is readily available. This tabulation is the result of an actual investigation of the various methods of pumping oil. The steam-engine plant, it is clear, requires the smallest investment, and the natural-gas engine nearly double the investment though it shows the lowest working cost. In the particular case here mentioned, No. 10 was adopted and individual plants containing 30-hp. gas-engines were built.

Number	Equipment.	Investment cost, per cent	Comparative working costs, parts per 100	Estimated working costs, c. per bbl. oil
1.	Individual steam-plant for each two wells, using oil for fuel....	100	100	8.20
2.	Electric motors at each well, necessary transmission lines, transformers, and receiving station; power purchased	100	80	6.60
3.	Central plant having air-compressors direct connected to gas-engines, using natural gas. Air distributed to each well for operating ordinary steam-engines	388	46	3.80
4.	Same as No. 3, except steam-driven compressors and boilers fired by natural gas.....	393	56	4.60
5.	Same as No. 4, using fuel oil. No gas lines....	337	73	6.00
6.	Central plant with steam turbines. Boilers fired with fuel oil. Electric motor 200 volt at each well	196	61	5.00
7.	Same as No. 6, except fired with natural gas	227	50	4.00
8.	Central plant. Engine-type generators, direct gas-engine driven. Electric distribution same as for No. 6....	264	44	3.60
9.	Individual internal combustion oil engine at each well	231	40	3.30
10.	Individual 30-hp. gas engine at each well, including gas mains and accessories	195	34	2.33

Complete gas-engine equipment consists of natural-gas engines of required power, gasometers for the regulation of gas pressure and supply, water tanks for cooling cylinder jackets, traps for collecting gas, scrubbers for condensation in gas lines, gas mains, a tail pump for pumping the oil from each well to central shipping tanks, and in some cases large gas-holders. The de-

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velopment of the gas is dependent on the quantity and pressure obtainable. In the instance quoted, measurements were made from the casing heads and lead lines at the wells, and pressure was taken by gauge and manometer tests. As the average pressure was low, it was decided to raise it to 15-in. water gauge by means of automatic gas traps, placed on the lead lines. The wells that yield gas through the casing heads give a slightly higher pressure, but a much smaller quantity. An 8-in. main was used for the sake of equalizing pressure. The placing of the automatic gas traps on the lead lines does not interfere with the flow of oil from the well, as they are not affected by the admixture of sand with the oil. They can also be arranged for varying pressures.

Gas-engines of the four-cycle type and 30 hp. were selected for use. They were placed on substantial reinforced concrete foundations, and each was provided with a centrifugal pump for water-jacket circulation. The transmission is equipped with a five-arm clutch driving pulley, spur gearing being provided for reversing. As the developed pressure of gas is too low for successful hot-tube ignition, magnetos were placed on each engine, high-tension spark plugs being fitted to the usual hot-tube connection. The magneto is placed on a bracket, central with a timing gear by which the spark can be advanced or retarded by means of a screw and wheel, thereby giving complete control of the point of ignition to suit the operating load conditions. A cord is also run to the rig, by which, through the governor, the operator controls the speed when pulling the tubing. The engines use an average of 4000 cu. ft. of gas per day while pumping, and nearly 600 ft. per hour when pulling or cleaning a well, the average depth of wells being 2745 ft. They run at about 160 r.p.m. when pumping, and when pulling a well at about 250 r.p.m. and develop full rating. For efficiency, the gas-engine gives a steadier motion to a pumping well than a steam-engine, and the well can be pulled equally as quickly, especially when the clutch is arranged to run back at double the hoisting or forward speed. The arrangement of the usual reverse gear does not permit of as rapid work in bailing, as it is dependent on the clutch shoes, which wear quickly, by reason of the constant reverse action. Drillers do not like gas-engines as well as steam-engines, since the motion is regular, and does not permit the tools to accelerate in dropping. A good well-driller can, however, successfully operate, clean, and re-drill by means of the gas-engine.

The cost of operating by gas-engine depends on the position of wells, and the number of wells that one pumper can look after. Wells placed 8 to the mile or 711 ft. apart will require one attendant to 8 wells per shift; if closer, 10 to 12 wells may be properly looked after. It is necessary to have a gas-engine engineer in charge, to watch operations and to make all adjustments and repairs. Tail pumps are either connected to an overhung extension of the walking-beam, or attached to the underside, near the Samson post. Both are operated practically by the weight of the sucker-rods, which overbalance the opposite end. These pumps draw from a sump, or tank, which receives the oil from the lead line of the well, and they deliver the oil direct to the central receiving tanks for shipment. This arrangement is necessary, as no other power is available with a gas-engine equipment, and no other type could be operated as cheaply.

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The cost of pumping by gas-engines with one pair of attendants to 8 wells, together with a proportion of the cost of repair crew, is as follows:

	Per Month.
Labor, two men at $3.50 per day	$210
Lubricating oils, $7.50 per well	60
One-quarter of two repair-men at $8.50 per day	66
Repairs and replacements	120
Total	$456

This is equivalent to $57 per month per well. The cost of pumping 100 bbl. per day is 1.9c. per barrel.

The cost of operating steam-plants 100 month-wells, is as follows, per well per month:

Labor attendance	$104.88
Fuel oil	105.47
Labor, scaling boilers	15.62
Repairs, material	9.57
Engine repairs	5.56
Lubricating oils	7.73
Boiler flues	4.00
Water	17.17
Total	$270.00

On the same basis of 3000 bbl. per month, the cost is 0.09c. per bbl. A saving is shown in favor of the gas-engine of $213 per month per well, or 7.1c. per bbl. of oil. The estimated working cost as tabulated gives 8.2c. for steam and 2.33c. for gas-engines. The actual results show a saving of approximately $2500 per year per gas-engine erected and in running order. This cost will depend on the length and size of the gas mains required and other local conditions, and will lie between $2500 and $3000 per well. It must be understood that these are the controllable costs of actual pumping, based on 100% of time performance, and are only a portion of the full costs for producing oil which include maintenance, cleaning, changing pumps, and many attendant troubles and expenses. The figures represent actual performance and go to show that with a lease having a normal supply of natural gas, good economy can be effected by changing from existing steam-plants to gas-engines, and the investment and expenditure necessary will be amply justified by the results.

THE LAKE VIEW WELL WHICH NEEDED NO PUMP.

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Irrigation in Northeastern Brazil

By G. A. WARING

OPPORTUNITY to study the water conditions in northeastern Brazil was recently offered during reconnaissance of about four months under the direction of M. A. R. Lisboa, chief of the *Inspectoria de Obras Contra as Seccas*, a federal bureau that corresponds to the Reclamation Service of the United States; and obligation is here expressed to him for aid furnished in collecting much of the general material concerning the region, and for permission to publish the notes on the work of the Inspectoria.

The region visited comprises the states of Piauhy, Ceará, Rio Grande do Norte, Parahyba, Pernambuco, Alagoas, Sergipe, and Bolivia, and embraces about 450,000 square miles, one-seventh of the entire area of the country. It is entirely within the tropical zone, being between the parallels of 3° and 13° south latitude. It constitutes an extensive plateau, but three general topographic divisions may be made. These are, a coastal belt, an interior plateau, and extensive table-lands that rise above the plateau level.

The coastal belt has a minor relief made by sand dunes and occasional rocky hills. At several places near the ocean the dunes attain a large size and obstruct the mouths of streams.

The interior plateau is in its main features a great gently undulating plain, but the monotony of its surface is relieved in many places by isolated hills and small ranges. A number of these form drainage divides; but other prominent ranges are situated within the boundaries of river basins. Among these are Serra de Jacobina and other subsidiary ranges in Bolivia, and several detached ranges in the region farther north. Among the two that are of chief topographic interest are a remarkably straight north-south range in the east-central part of the state of Ceará, and a similarly straight east-west range in western Parahyba. These two are of especial engineering interest because each is crossed by several rivers, through narrow canyons or short gorges that furnish good damsites.

The higher table-lands that rise within the plateau are mainly separated from the surrounding area by prominent escarpments; though Planalto da Borborema, which is one of the most extensive upland areas, is bounded only by prominent but not ususually steep slopes. This planalto has a mean elevation of 1500 ft. above sea-level, and extends from the southern portion of the state of Rio Grande do Norte southward across central Parahyba. Chapada do Araripe is a prominent table-land that lies along the southern border of the state of Ceará. This chapada is roughly 20 by 100 miles in extent. It

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is remarkable for its flat surface and for its limiting escarpments, and because a large portion of its margin is formed by a standstone cliff 100 to 300 ft. high. The chapada rises 1200 to 1500 ft. above the surrounding plain, and has an elevation of 2500 to 2800 ft. above sea-level, being the most elevated area of great extent in northeastern Brazil. From the western end of Chapada do Araripe, Serra Grande sweeps northwestward and northward along the boundary of the states of Ceará and Piauhy, and continues northward with the name of Serra da Ibiapaba, to within a few miles of the coast. A prominent escarpment forms the eastern limit of this upland area; but thence its general surface descends gently to the western border of the state of Piauhy. Along the border between the states of Ceará and Rio Grande do Norte a minor table-land known as Chapada do Apody rises gradually from sea-level to an escarpment that is 300 feet high, on its southern and western borders.

Although the region is only a few degrees from the equator its climate is arid rather than tropical. It is similar in its main features to the climate of southeastern California and southern Nevada. During the dry season, which varies from May to November and July to January in different portions, the days are hot but the sky is often partly clouded. The heat is not more unbearable than is that of the southwestern United States, and the extremes of temperature are not so great. The nights are sufficiently cool for comfortable sleep, but are not chilly. During the winter the rains are warm and are usually of only a few days duration.

There are many cocoanut palms at several places along sandy portions of the coast, and along the lower portions of some of the stream valleys there are groves of other varieties of palms. On the higher slopes there are a few areas of low trees, but in no part of the arid region are there real forests. In the humid southeastern portion of the area shown in Fig. 1 there are dense forests, however. By far the greater portion of northeastern Brazil is covered with a growth known as *catinga*, which consists of tall brush, cactus, and scrubby trees. Among the varieties of trees are several hardwoods that are used locally for purposes of construction.

There are a few cities of importance along the coast, but the region is as yet sparsely peopled. The interior towns are mainly settlements of less than 1000 inhabitants, and the ranches are in most places several miles apart. The people of the interior are largely of negro descent, mixed with the native Indian and with Portuguese, and as a rule they are not energetic workers. To some extent it is rightfully claimed that their backward condition is due to sloth and ignorance; but in most of the area life for them is a struggle against the usual adverse conditions of an arid region, increased by periods of famine due to prolonged droughts. They are by no means irresponsive to better things, and when the natural conditions permit they improve the chances for betterment. It must be distinctly understood that they are not a helpless people, dependent for existence on the government care. They are capable of self-improvement when they are shown how best to work; but their limited means has rendered them pitifully dependent on the rainfall for a livelihood, as they cannot construct storage works of sufficient size to withstand long periods of drought.

Throughout the greater part of the

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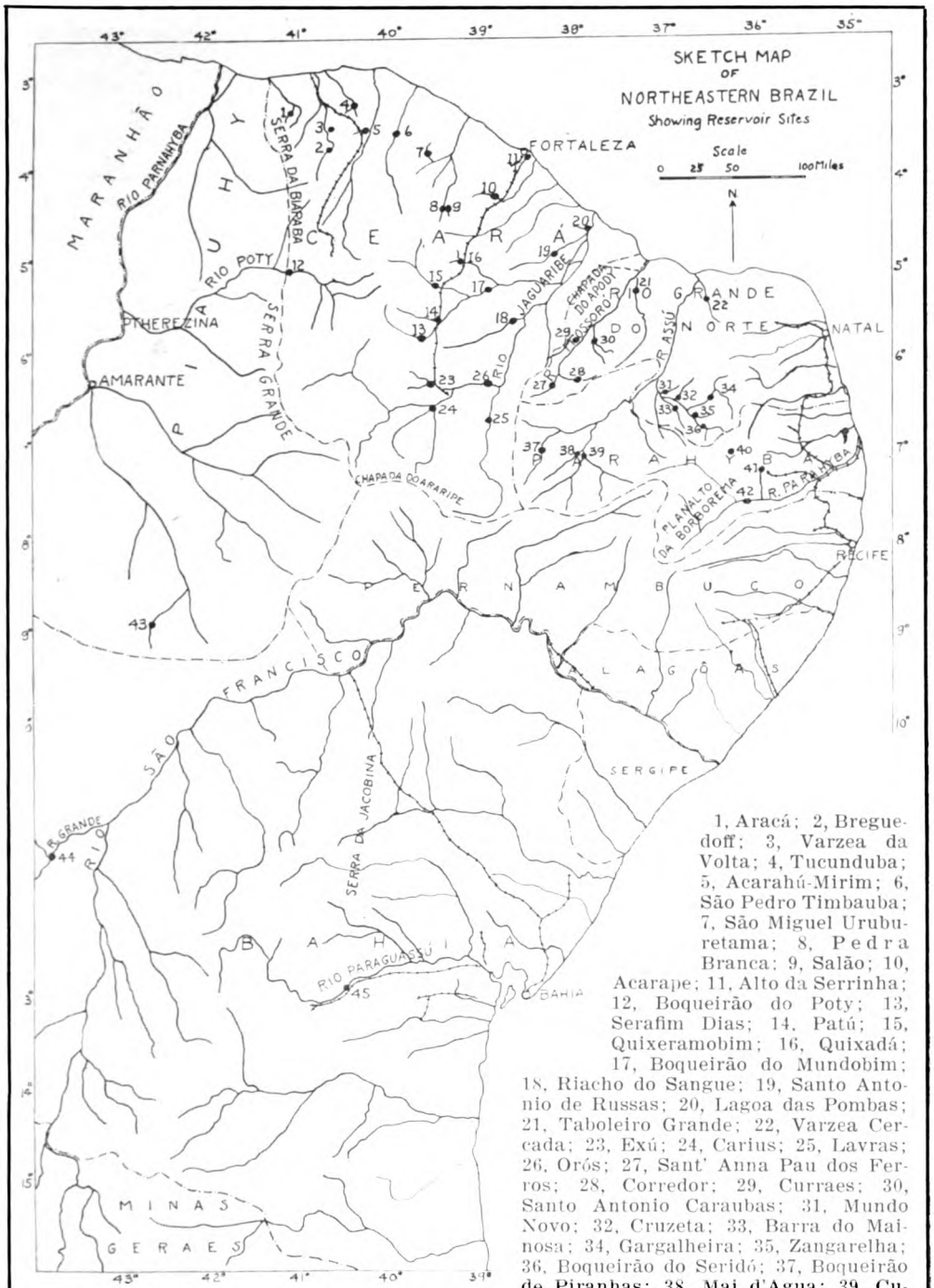

1, Aracá; 2, Breguedoff; 3, Varzea da Volta; 4, Tucunduba; 5, Acarahú-Mirim; 6, São Pedro Timbauba; 7, São Miguel Uruburetama; 8, Pedra Branca; 9, Salão; 10, Acarape; 11, Alto da Serrinha; 12, Boqueirão do Poty; 13, Serafim Dias; 14, Patú; 15, Quixeramobim; 16, Quixadá; 17, Boqueirão do Mundobim; 18, Riacho do Sangue; 19, Santo Antonio de Russas; 20, Lagoa das Pombas; 21, Taboleiro Grande; 22, Varzea Cercada; 23, Exú; 24, Carius; 25, Lavras; 26, Orós; 27, Sant' Anna Pau dos Ferros; 28, Corredor; 29, Curraes; 30, Santo Antonio Caraubas; 31, Mundo Novo; 32, Cruzeta; 33, Barra do Mainosa; 34, Gargalheira; 35, Zangarelha; 36, Boqueirão do Seridó; 37, Boqueirão de Piranhas; 38, Mai d'Agua; 39, Curema; 40, Soledade; 41, Bodocongó; 42, Boqueirão de Cabaceiras; 43, São Raymundo Nonnato; 44, Boqueirão; 45, Caixão.

FIG. 1.

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region the people live a kind of feudal life. A few are landholders, and those who are not, obtain permission from some ranch owner to erect their dwellings on his property. They then enter the service of the landlord, being employed in caring for the cattle, building and repairing fences, and clearing and cultivating small fields. Nearly every family has its band of goats, which supply meat, while the skins are sold to buy other necessaries. Many families also have a small garden where corn, beans, or *mandioca* are grown. Although the staple foods, which are beans, rice, *farinha* (meal of *mandioca* root), and dried meat, are produced in large enough quantities for local consumption during normal years, agriculture is still in its infancy, and crops are extensively exported from only a few localities that are naturally favored. Much sugar-cane finds a local market in the form of bricks of crude sugar and as a variety of rum known as *aguardente*. There is also a large total export of cotton that is gathered from many small fields, and this cotton is well and favorably known in the markets of Europe. The region is essentially a stock-raising one at present, however, and goat skins and cattle hides form a staple article of export.

Records that have been kept since about 1600 show that numerous periods of drought and consequent famine have occurred. Since the great famine of 1825, when federal aid was first sent to the sufferers, the relief of the people during periods of drought has become a national problem. In the earlier years, money and provisions were distributed directly to the people; but during a severe drought in 1844-45, the repair of public works and the construction of roads were undertaken as a means of providing employment and hence of giving wages to the people. No well-planned works to provide for the storage of water were undertaken, however.

A period of 31 years without serious droughts followed that of 1844-45; but in 1877-78 a drought which, because of the greater population, was felt more severely than the previous one, nearly depopulated portions of the northeast. During this drought the construction of a number of works for the storage of water was undertaken; but most of those that were finished proved to be of little or no use because their situation or methods of construction were ill-chosen. In 1888 there was another severe drought in portions of the northeast, and the effects of this period of famine resulted in a few general studies being made of the regions that had suffered most severely. The year 1898 was another drought period; and from that date to the present time, as the population has increased and conditions in the interior have become better known, the injurious effects of the dry years have become more clearly realized.

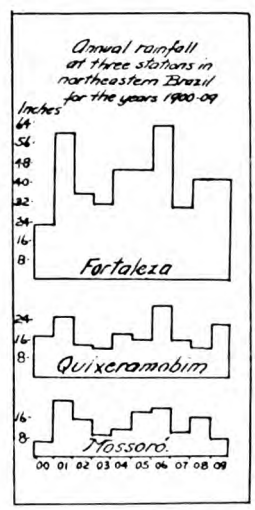

Fig. 2.

In order to undertake systematic work for the relief of the arid region there was organized in 1904 three federal bureaus, known as the 'Commission for Reservoirs and Irrigation,' the 'Commission for Studies and Works Against the Effects of the Drought,' and the 'Commission for Sinking Wells.' A number of studies were made by

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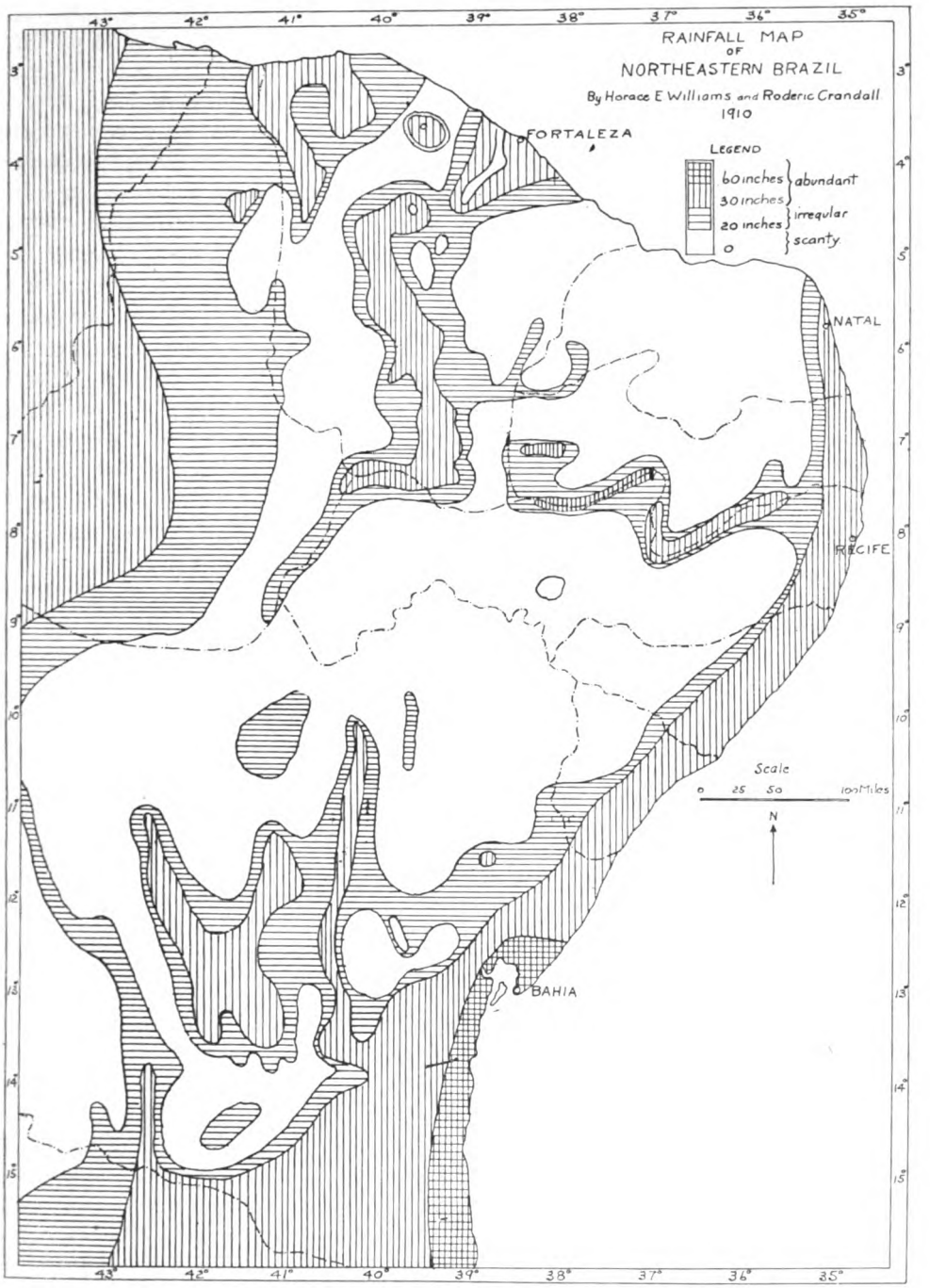

FIG. 3.

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these commissions, and a few works were constructed, the service being reorganized and consolidated in 1909 into a bureau known as the *Inspectoria de Obras Contra as Seccas* (Service of Works Against the Droughts).

During the days of the commissions it had come to be recognized that the suffering in the arid region is caused as much by the irregularity of the rains as by their absence; for in some years floods have destroyed the crops, while in others the early rains have not been followed by the later ones needed to mature the crops. It is now realized that effects of the irregular rainfall can be overcome by the construction of storage reservoirs and many have already been built.

During the past years the building of reservoirs and other allied works has been greatly hindered by the lack of maps and the absence of knowledge concerning water conditions in the arid region; but since the organization of the Inspectoria two years ago the region has been mapped, the principal river basins have been examined and the feasible reservoir sites found, and general plans for the development of the region have been outlined. Besides these direct works, the Inspectoria has made studies of the agricultural capabilities of the various portions of the region, has established rain-gauging stations, and has initiated a systematic measurement of the discharge of the rivers.

The entire northeastern portion of Brazil is not arid, but the areas that have a probable average of more than about 20 inches of rain annually are limited to a few mountain ranges and to a narrow zone along the coast. The approximate amount and geographic distribution of the rain is shown on the sketch map, Fig. 3. The monthly and yearly distribution of the rain is very irregular, however. Only a few rainfall records covering periods of more than two or three years are yet available, but the graphic records, Fig. 2, which show the monthly and annual precipitation at the three fairly typical places, Fortaleza, on the coast; Quixeramobim, 120 miles southward and inland; and Mossoró, about an equal distance to the southeast, give an idea of the great irregularity of the rainfall.

Until recently no systematic measurements of the discharge of the rivers had been attempted, and the only available information concerning this matter consisted of estimates based on the probable average rainfall, the areas of the river basins, and an assumed percentage of run-off. Such estimates give an approximate idea of the total annual river discharge; though in the plateau region of northeastern Brazil, where the river basins are shallow, the amount of run-off is greatly influenced by the rate of precipitation. This factor of rate of precipitation, which determines the regimen of the streams, is a matter concerning which information has only begun to be collected; but under the direction of Mr. Lisboa a network of rain-gauging stations has now been established, and similar work in relation to the river flow has been undertaken. Records of the approximate daily discharge of several rivers during the winter of 1910-11 have been obtained, and three of these records, together with the corresponding rainfall records, are shown graphically in Fig. 4. These illustrate the short and floodlike character of the river discharge and its close relation to the rainstorms. The graphic records of the rainfall in the basins of Rio Acauán and Rio Piancó also show the irregularity in the geographic distribution of

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precipitation. The average rainfall in these two basins, about 100 miles apart, is believed to be about the same; but during the winter 1910-1911 the basin of Rio Acauán received considerably less than its share, while that of Rio Piancó probably received more than its average amount.

the present scattered population will become collected into agricultural communities, and a general advance will be made in the condition of the people and in the commercial development of the region. Provision will also be made for the colonization of some of the irrigated areas, in order that a more rapid de-

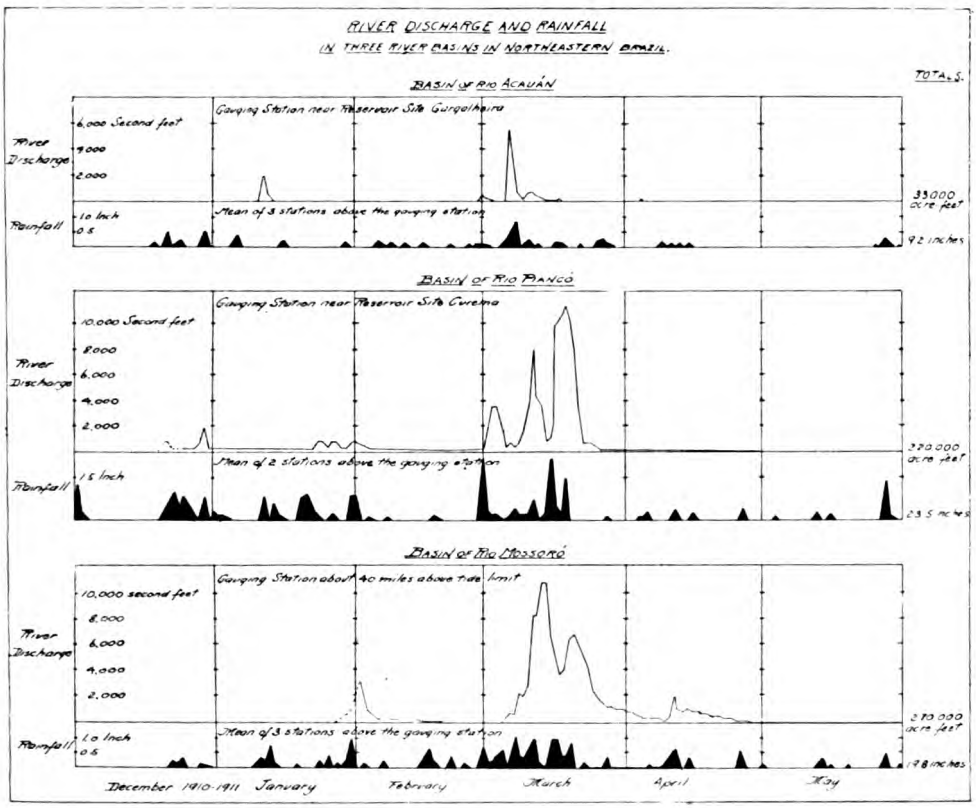

FIG. 4.

The 'works against the droughts' will consist mainly in the construction of irrigation projects; and these will be administered along the general lines of the U. S. Reclamation Service, provision being made for the purchase of land with water-right by individuals. Although the population is sparse, it is believed that the people will migrate to the irrigated areas during times of drought, and will remain there. Thus

velopment of the region may be aided by this means. Besides the larger irrigation works many reservoirs will be constructed that will serve to hold reserve supplies of water for the use of villages and as watering places for the cattle and other domestic animals. Such works will be of relatively little use except in times of drought; but in this respect they will be like 'protective works' (against famine) in India.

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In addition to the larger reservoirs, some of which will be built by federal aid alone and others in co-operation with the separate states, private owners are being aided by the Inspectoria, which furnishes engineers for the survey of reservoir sites and canal lines, and also encourages the construction of small private reservoirs by offering premiums as a stimulus to individual effort.

The extent to which the population and the cattle are dependent on the surface-water supply is well shown by the sketch map, Fig. 5, on which the private reservoirs in a portion of the state of Rio Grande do Norte are indicated. These reservoirs are formed by small earthen dams; and the water that is stored in the shallow basins is always muddy and becomes stagnant during the latter part of the summer. It is the only supply in many places, however, because hard rock is close to the surface, and the people have not been able to make wells with the limited implements at their command. These small reservoirs also furnish a large part of the cultivated land of the region; for as the water recedes, rice, beans, and other quickly growing crops are planted in the moist strip around the margin. Some of the reservoirs also yield a considerable amount of fish. In many portions of the arid region the underground water can be made available by wells; so the Inspectoria will drill wells in a number of towns and install machinery for the supply of water to the inhabitants.

During the period prior to the organization of the Inspectoria, two large reservoirs were constructed by federal authority, and plans for several others were drawn. During the past two years the Inspectoria has made other surveys, and in September 1911 had under consideration approximately the following works for water development: 19 reservoirs providing more than 8000 acre-feet, of which 3 are in construction; 5 reservoirs of 1500 to 8000 acre-feet, all of which are in construction; 26 reservoirs of less than 1500 acre-feet, 3 of which are in construction; 12 well-drilling parties organized and 9 other

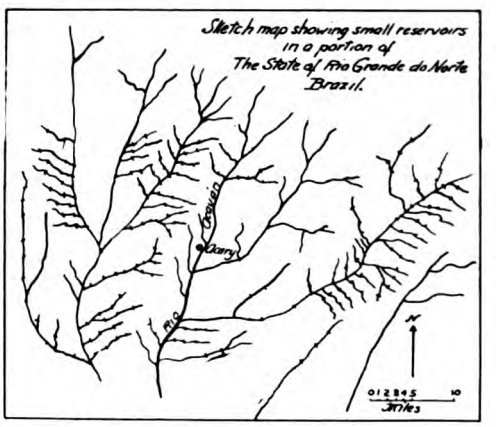

FIG. 5.

Keystone drilling machines ordered; 16 wells have already been drilled, and others are rapidly going down.

Reservoir Quixadá.—The largest reservoir that has yet been constructed in northeastern Brazil is on a small stream in the state of Ceará (see Fig. 1). While it is an inefficient structure because it has never become sufficiently filled with water to allow of extensive irrigation, the trouble seems to have been due chiefly to the lack of good maps of the hydrographic basin, and of information concerning the amount of run-off. The construction of the work was excellent, and besides furnishing a water-supply in reserve against droughts, the project does irrigate some land down-stream by means of canals. It has a capacity of 111,450 acre-feet, but it has not been filled above the 30-ft. level, giving a content

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of 34,500 acre-feet. The reservoir is formed by four dams, as follows:

Dam.	Material.	Length, Ft.	Max. Ht., Ft.
Central	Masonry and concrete..	1360	51
North	Earth faced with stone.	685	16
South	Earth faced with stone.	800	56
Extreme	Earth	1520	7

The project was studied in 1882 by J. J. Revy, an English engineer, and construction was authorized by the Imperial Government in 1884. At that time the railroad had been constructed only to a point about 60 miles distant from the reservoir site, so that much preliminary work was necessary in making a wagon-road, and the transportation of material was slow. Work was stopped several times because of the lack of material or of funds, and construction was not finished until 1906. Much of the canal work has been added since that date.

Reservoir Acarahú-Mirim.—The only other large reservoir besides that of Quixadá which has been completed in northeastern Brazil is that of Acarahú-Mirim, 6 miles east of the railroad, in northwestern Ceará. This reservoir has a capacity of 48,600 acre-feet, and is formed by an earthen dam 1450 ft. long and 59 ft. in maximum height. It was completed in 1907, and overflowed to a depth of several feet on the waste-way, in 1910. There is some cultivable land down-stream from it, but irrigation canals have not yet been constructed.

Reservoir Lagoa das Pombas.—The reservoir of Lagoa das Pombas is situated near the coast, at a place where there is a chain of seven lagoons. By means of a low dam across the outlet of the lowest one, a wide shallow reservoir with a capacity of 16,200 acre-feet has been made. During the winter the reservoir fills and submerges a large area of lowland, and as the water recedes during the summer this is planted to rice and other suitable crops.

Reservoir Breguedoff.—Reservoir Breguedoff is situated on one of the minor coastal streams of northwestern Ceará. It was partly constructed by federal aid in 1888; but the earthen dam was broken during later winters, and the structure was rendered of no use. It was reconstructed by the Inspectoria, in 1910, with a capacity of 5100 acre-feet, and furnishes a permanent water-supply for a nearby village and for the cattle of the surrounding range.

Reservoir São Miguel Uruburetama.—Like Reservoir Breguedoff, that of São Miguel Uruburetama was constructed by a previous drought commission, in northwestern Ceará; but it was not kept in repair and was broken by high water after a few years of service. The dam has been repaired by the Inspectoria, and increased to a height of 39 ft., giving a capacity of 1140 acre-feet. It forms the water-supply for a nearby village and for the cattle of the locality.

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Menace of Water in the Oilfields

By W. H. STORMS*, and PAUL W. PRUTZMAN

EVERY petroleum-producing region sooner or later suffers the disastrous results which follow the appearance of water in the oil wells. So great is the loss usually attending the encroachment of water upon the oil-sands that nearly every oil-producing state has passed laws having for their object the prevention, as far as possible, of the infiltration of water into the oil-bearing sands, whatever may be the cause. Over every producing oilfield in California hovers the unwelcome spectacle of water in oil strata. The entry of water into oil wells is due to a variety of causes, and in many instances it can be controlled. In other cases the remedy is more difficult and expensive. In still others there is no remedy. Recently the senior author of this paper went through the several California oilfields and found water in evidence everywhere. Many wells, which a short time since were productive and profitable, had gone over in large part to water, and others were showing a rapid increase in water. Some of them were making practically nothing but water, while those making 60 to 85% water were common. So general is this condition in parts of all the several districts as to constitute a menace as to the principal fuel supply of the Pacific coast. Some remedy should be promptly applied.

Fortunately, the mechanics of the matter are well understood by many of the more experienced oilmen. What is wanted is coöperation in applying remedies, and also much money is needed. Various coöperative plans have been tried, but have proved ineffective. At a meeting of oilmen at Bakersfield March 9 the entire matter was canvassed. It was decided that the best means of securing the necessary money was by assessment on both acreage and production. There are about 130,000 acres of land recognized as oil territory in the 'west side' fields. By the levy of an assessment of 2½c. per acre on this land, and 1/15% on each barrel of oil produced, about $5000 monthly can be realized. This amount, placed in the hands of the water commissioner will, it is thought, permit an effective campaign of correction. Recommendations to this effect were unanimously adopted and the water commissioner was authorized to employ as many deputies as he required, and he was urged to carry on the work with vigor. It now remains to be seen to what extent those most interested, the oil operators and owners of oil lands, will respond to the call for money to carry out the plans agreed upon.

In the meantime, it is important, with a view to possible additional steps, to understand thoroughly the actual

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conditions in the field. The following paragraphs have been prepared by the junior author of this paper as a result of field studies made in the course of work for the State Mining Bureau.

Water has entered the oil-sands in dangerous quantity at many points. In the Fullerton field but small areas have been affected by water, and the subject has not attracted much attention. The southern portion of the district is now being troubled and the danger is likely to increase. In the La Habra district there is, as yet, no damage, but injudicious methods of drilling are likely to make difficulty. The Coyote is a small field that has had much trouble with water from the start. It was pioneered by the Murphy Oil Co., whose engineers seem to have done the best they could under great difficulties. The Union Oil Co. is now having trouble on the Bastanchury and San Juan leases. In the Whittier field water difficulties thus far are limited. The Murphy and Central leases have had some trouble along the north line of section 26, which could probably have been easily remedied. Some of the smaller companies on section 22 have had a little trouble, though none of serious nature. The Los Angeles City field has almost entirely gone over to water, and there is hardly a dry well. It is so nearly exhausted that correction, even if possible, would not be profitable. The Salt Lake field has been badly handled and at the west end water has largely destroyed the production. In the Newhall, trouble with water is confined to small groups of wells. In Ventura county the wells are divided into small disconnected groups, and water troubles have occurred only in isolated cases. At Santa Maria, the west side, or old field, was originally dry, but all the wells are now making considerable water, the source of which has never been certainly determined. For a time the trouble was severe on the south side, and it has never been entirely overcome, but has been considerably lessened by various expedients. The Water Association here has done little beyond exchanging ideas, and there has been much dissension, yet on the whole considerable good has been accomplished by individual operators. In Cat Canyon there has been a great deal of trouble on the Bell ranch, and in wells in Cat Canyon proper, due largely to bottom water. There is probably no remedy for the difficulty there. At Summerland a great deal of water trouble has occurred, and the production of the field went down at one time to a small figure. Most of the wells have now been brought under the management of two men who work together, and many of the wells are being recovered. While the production of this field is small, much interesting information can be had as to recovery methods.

In the Kern River field the wells are shallow, and as they were punched down without regard to results, the entire field is wet. Great efforts have been made to shut off the water, but generally without satisfactory results, and the only successful work has been due to the introduction of the system of pumping by compressed air.

At Coalinga serious water troubles have developed, mainly at the east and south of the field. The value of section 6 has been affected, and that of the properties in the northeast corner of the field greatly impaired. Along the east margin of the southern part of the field (down the dip) water is appearing in quantity, but it has not been determined whether this is due to reaching permanent water-level or

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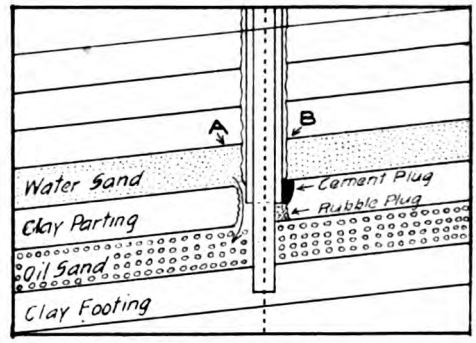
to leakage. In the northeast the trouble is undoubtedly due to bad work and is largely subject to correction. Great efforts have been made to form a water association here, but for some reason little had been accomplished until recently. In the Sunset-Midway field most of the trouble has been along the east line, and more toward the south than in the north.

The conditions under which water may enter the oil-sands in dangerous quantity may be summarized as follows:

1. Where upper water is not cemented off and landing fails to hold, a leak may develop around the foot of the water string, allowing water from above to percolate into the sand. The continual flow of water in one direction, when the pressure on the oil-sand has been reduced by pumping, usually destroys the seal rapidly, and forms a channel for free passage of water. This water always shows first in the defective well, but often not for some time after the well is finished. This condition is common among the older wells in shallow territory, particularly on the west side of the San Joaquin valley. It is easily corrected where the pipe can be drawn. The work is not costly, and leaves the well in good shape. When the parting between water and oil-sands is sufficiently thick, such a well may be corrected by drawing the inner string, plugging on top of the oil-sand, cementing the water string, and drilling out the plug. In Fig. 1 the condition before treatment is illustrated at A, and that after correction at B.

2. Where the parting between water and oil-sands is too thin to hold cement or give an effective landing for water string which was not anticipated by drillers, the full-size hole has often been carried through into the oil-sand with little or no attempt to shut off water. The water, as in the first case, finds its way by gravitation or by difference in pressure into the oil-sand, and shows first in the defective well, usually as soon as the well is put to



-Figure 1-

pumping. This case is common in the Kern River field, where the clay streaks between water and oil-sands are often but two or three feet thick. All attempts to correct these wells have so far failed, but good has been done by pumping large volumes of water direct from the water-sands with air-compressors, by which the water has been partly or entirely exhausted. In cases where accurate logs exist, and the casing is in condition to be handled, a parting may be found farther up in which most of the water may be cemented off, or two parting layers with a water-sand between may be filled with a cement plug. Even where possible, this work is costly, and the results doubtful. Where there is no log of the well, or an insufficient one as is more often the case, no remedy has been suggested. In Fig. 2, A illustrates the condition before treatment, while B shows cement run into a water-sand and two layers of clay.

3. Where a cemented job has failed to hold because of channeling of or

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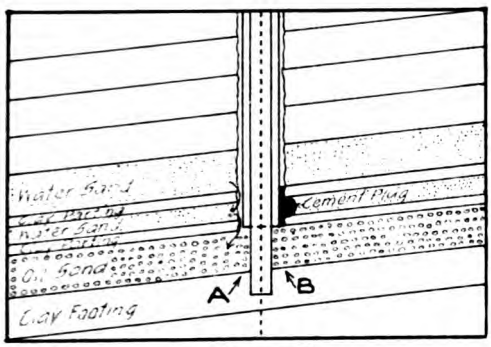
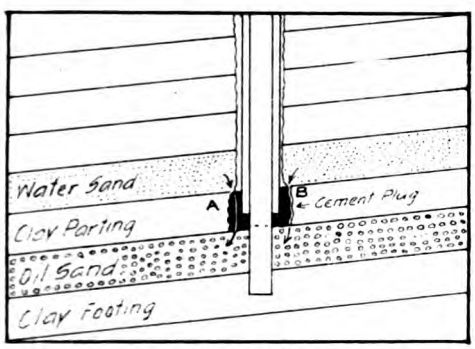
around the cement, the trouble is usually due to failure to clean out the hole before cementing, to oil on sides of the hole, or to pumping in too much



- Figure 2 -

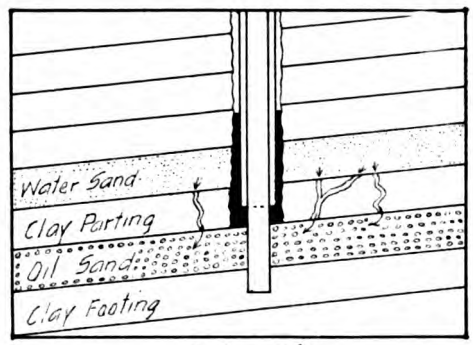
water in cementing by the tubing method. These conditions may and should be avoided in cementing, but often through unskillful handling, and ignorance of underground conditions, the job fails from one of these causes. Fig. 3 illustrates leakage through ce-



- Figure 3 -

ment at A and around cement at B. Such cases are common in deep territory, and emphasize strongly the need of better engineering skill and more information in cementing deep wells. The remedy applicable is to cut off the cemented string, draw the casing, redrill, and re-cement. This is always difficult, expensive, and uncertain, and sometimes impossible. Where a second cementing fails to hold, the case is usually hopeless, and reduction of pressure on the water-sand by pumping is the only palliative.

4. Where the leakage of upper water takes place through the parting, and where repeated cementings have failed to hold, the claim has been made that water was passing through channels in the parting layer, back of the cement. (See Fig. 4.) It is doubtful whether



- Figure 4 -

this can take place, since if the parting was already channeled it would seem that the gravity difference would carry water into the oil-sand as well before drilling as after. It is possible, however, that in rare cases weak or porous spots exist in the parting, which spots would be tight as long as pressures were balanced, but which would leak or blow out when hydrostatic balance was disturbed by exhaustion of the oil-sands. Where there is reason to suspect this condition, heavy pumping of the water-sands would, as in the case above, afford some relief and possibly a cure. This, however, entails continuous expense, but in at least one case, one of the Gilmore wells in the Salt Lake field, has been tried with excellent results. Such cases as indicated, if they actually exist, would be quite beyond permanent remedy, as there would be no way to find the

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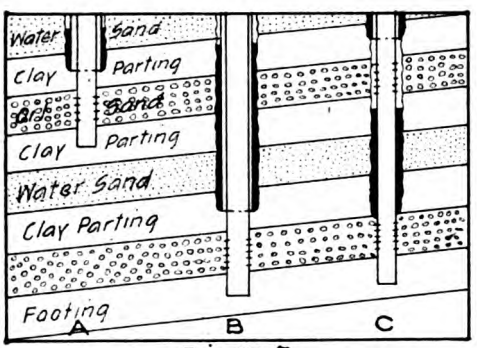
channels or to reach them with plugging material. It is probable, however, that this case is much less common than is supposed.

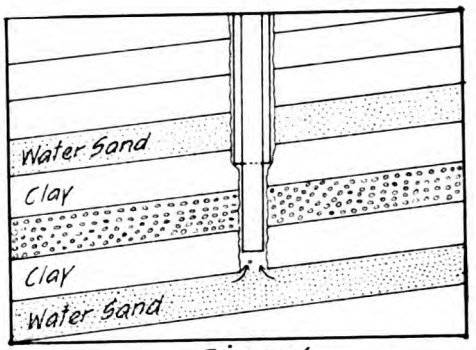
5. Where a water-sand lies between two oil-sands the difficulty may be handled in three ways: (1) by entering the top sand only, and landing the oil string in the first parting streak (see A, Fig. 5); (2) by cementing off



- Figure 5 -

the top oil-sand and the middle water-sand, and perforating in the lower oil-sand only (see B, Fig. 5); (3) by cementing off top water and the middle water-sand, and perforating both oil-sands (see C, Fig. 5). The first and second methods amount to drilling two wells to do the work of one, which in deep territory is very expensive. The third is seldom successful, as it is difficult if not impossible to place two separate cement plugs. Several wells on section 6-21-15, Coalinga, appear to have found such a middle water-sand. As these were drilled through to the second sand without cementing (after upper water was shut off) the water from this middle water-sand has free access to both oil-sands. The only remedy in this case is to cement off the top sand and perforate in the lower only, or to pull and plug the well.

6. When a well is inadvertently drilled through the footing into bottom water, the latter enters the bottom of casing, or around the shoe, and passes up into oil-sand (see Fig. 6).



- Figure 6 -

The remedy is to pull back and plug the bottom of the hole. This is simple in theory, but difficult in practice. Cement can seldom be properly applied, owing to the pressure of oil. Where the footing is thick and solid, a well tamped plug of rock and clay will sometimes hold. Such jobs as this are extremely tedious and expensive, and seldom effective. For instance, the wells on the Theresa Bell tract, Cat Canyon, numbered 1 and 2, were originally dry, but one was drilled through the footing in salt water because of an error in measurement of pipe, while the other was broken through in swabbing out running sand. Work on these wells has been going on about two years, but while part of the water has been shut out, the production has never been recovered.

7. Where the footing immediately overlies a bottom water-sand, and is too thin to afford a proper landing, the case is almost identical with case 2, but is much more difficult to handle because of oil at the bottom of the hole. In this, as in the previous case, water will usually but not necessarily show first in the defective well, but will spread to adjacent wells faster, as a

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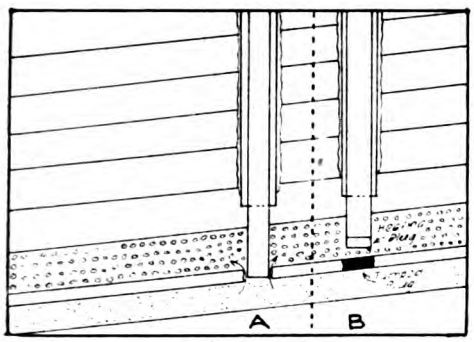
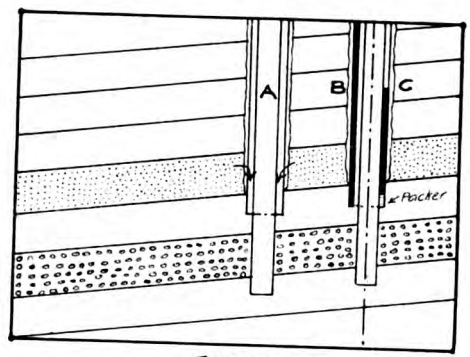
rule, than leakage from above. In Fig. 7, A illustrates the original condition of the well, and B the condition of



- Figure 7 -

the plugging. Where only an occasional well is so affected, the plugging and tamping of the worst wells will afford some relief. Wells so treated may still be pumped from the top of the sand. At Kern River a great many wells were sent too deep, as the footing in parts of the field were extremely thin. In such a case, exhaustion of the water-sand is the only hope.

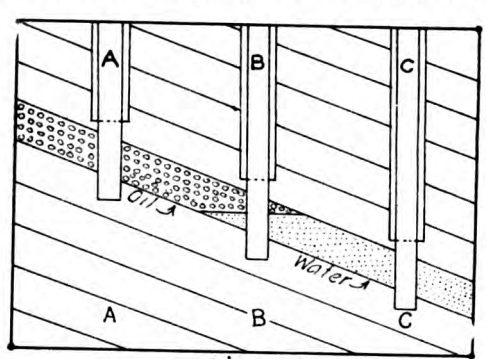
8. Upper water may be admitted through leaky or split casing. Casing, particularly the light pipe used in many of the older wells, sometimes leaks when placed, or may develop leaks after a time from jars, corrosion, or too much pressure. As a rule this leakage will affect only the defective well, though where the water string is entirely broken off, a large amount of water may be admitted—enough to travel to adjacent wells. The remedy will depend upon the condition of the pipe. If reasonably free, and strong enough to pull without too much risk, the water string may be drawn and replaced by sound pipe. This can but rarely be done in old wells, which are most likely to show this defect. If the water string is tight and the inner string is free, a liner may be cemented solid to the water casing, and a third string carried into the oil-sand, or a packer may be run into the oil string, and the space between this and the water string filled with cement through perforations in the oil string. Such work is hazardous, and as a rule the production from such wells does not warrant the cost. In Fig. 8, A shows



- Figure 8 -

the condition before treatment, B where the liner is cemented solid to the water string, and C where the water string is cemented to the oil string.

9. Wells far down the dip may enter water, or oil and water, at the calculated level of the oil-sands. The lower portions of the porous strata are filled with water, on which the oil rests, as indicated in Fig. 9. If the sands are



- Figure 9 -

thick and but slightly inclined, a well may draw both oil and water from the same sand (as at B), while a well

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farther up the dip (A) will draw oil only. Such cases are extremely difficult to distinguish from cases 6 and 7. Often, indeed, the only proof that this condition exists is afforded by wells still farther down (as at C) obtaining water only. No remedy exists for such a condition.

10. Where the withdrawal of oil from wells up the dip allows the water-level to rise to that of the lowest wells. This case is illustrated by the previous diagram, Fig. 9. All three wells may be taken to have originally produced oil, but as oil is pumped out, water rises to fill its place, until, at the stage illustrated, well C has entirely gone over to water, while well B yieds both water and oil. This case, being merely a development of natural conditions, admits of no remedy. In Kern River the wells farthest east, at first fair producers, soon went over to water, which gradually made its way west (and up the formation), while the output of wells near the apex of the dome was but little changed. Considerable sums were spent in attempts to shut the water out of these wells before it was realized that the oil had permanently migrated to a higher level.

While this discussion covers only the most elementary principles, enough has been said to indicate that this matter is highly complicated. The relief of the water situation requires two movements—one to regulate and control future operating methods, and the other to correct at least the most glaring of past errors, and to minimize the evils arising therefrom.

The first movement must, of necessity, be limited to education and moral suasion, as it seems improbable that drilling methods can ever be effectively controlled by law. It might appear that in the present state of the art of drilling wells, the most approved methods would be too generally known to need description, but such is hardly the case. The actual manipulations of well drilling are largely left to the drillers, who are usually wedded to 'rule-of-thumb' methods, which often fail of accomplishing the desired results. Great good could be accomplished by diffusing the results of experience in drilling, casing, and cementing wells, and more particularly by reducing this experience to order and system, showing under what circumstances each given experiment or plan had been tried, why it had been successful or unsuccessful, and in general by correlating experience with the principles of hydraulic engineering. A knowledge of at least the elements of hydrostatics and hydrokinetics is essential to the fullest success in drilling in California oil territory, and, lacking this, the results of hundreds of costly experiences are of little value. A really scientific and unbiased conclusion as to the relative value and applicability of the several drilling methods in use would receive much attention from drillers everywhere. A great many operators believe that the indiscriminate use of the rotary method is productive of harm. This, it would seem, is something that is susceptible of demonstration.

The correction of old work is much more difficult, and in it persuasion and argument play but a minor part. It is one thing to convince live operators that their best interests lie in so conducting their work as to avoid trouble; it is quite another to persuade them to undertake costly and often hazardous work to correct an evil from which, in many cases, they are not as yet the greatest sufferers. Three general plans have been suggested for carrying out correction work, these plans being, in

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brief, as follows: (1) voluntary association; (2) state control; (3) compromise plan, which contemplates placing the scientific and technical work in the hands of a state official or commission, whose duties would be to obtain, correlate, and make public, well logs, cross-sections, and all other date, and to furnish engineering advice on demand, but to leave the financing and prosecution of corrective work to private or association initiative.

Each of these plans has its advantages and its drawbacks, but to be entirely successful the plan adopted must meet the following requirements:

1. Some competent authority must be set up to determine whether a dangerous condition really exists, and whether the extent of the danger justifies the probable cost of doing away with it. The first requirement is absolutely impartial advice from a competent engineer, commission, or association.

2. The plan must provide either for a decision as to whether such work shall or shall not be done, by an official with arbitrary powers, or it must hold out a reasonable prospect of agreement in most cases among the parties at interest. Scattered and haphazard work will be of but slight and local value.

3. Relief from the evils arising from the present situation, calls, above all things, for the fullest measure of publicity.

4. Funds must be provided, either by contribution, assessment, or taxation. There is a class of bad holes, common in the 'west side' fields, drilled by companies which have long since passed out of existence. Some of these were drilled on public land that has since been re-located, and the liability of the present owners of the land for damage resulting from such holes would be a nice legal question. Practically, it will be necessary for whoever undertakes such work to bear the entire cost in such cases as this.

5. A competent and permanent engineering staff must be provided for the supervision of work undertaken by individuals.

Voluntary association has the one great advantage that it is immediately applicable, and requires no legal action of any kind. Where the proper spirit exists, and in particular where there is some strong man to take the lead, the first, second, and third requirements can be met by properly organized water associations. It must not be overlooked, however, that success requires favorable circumstances, and that with the one exception above named, that at Santa Maria, all such organizations have, in the past, been lamentable failures. This is less due, in my opinion, to absence of the right spirit than to lack of initiative and guidance, and even more to the failure to provide skilled and disinterested advice as to practical questions. The old saying that 'everybody's business is nobody's business' is particularly applicable in this connection.

State control offers a solution for all difficulties, but requires so much legislative action and gives such far-reaching powers to the commission, that it seems out of the question at present. It may well be doubted whether, even if the necessary laws could be passed, the actual extent of the danger justifies giving any commission such arbitrary control over private property as would be necessary to success. To make the work of such commission at all possible, it would need the legal authority to demand, under adequate penalty, full and complete logs of all wells, and all obtainable data as to productiveness of

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various oil and water-sands; the right of free entry and examination of all wells at all times; the power to condemn, and the funds to pay for all dangerous wells, where owners were unable or unwilling to carry out the work required; the power to hold such charges as a lien on corrected wells, and to recoup costs by the sale of condemned property; the power to enter into contracts for work, and the funds to maintain a large working force. It is needless to dwell on the difficulty of setting such an elaborate and far-reaching plan in motion—it would be justified only by the most pressing necessity, following the failure of all other plans.

The compromise plan proposes to divide the work: the plans to be submitted by a state engineer, the work to be done by the individual operators or associations. The only action of the legislature would be the creation of a permanent state water commission, either as an entirety or as a branch of some state department, consisting of an engineer in charge, a small force (drafting, chemical, and clerical), with a competent assistant in each field. The duties of this office would be: (1) to determine accurately the extent and location of the danger from water, and make a comprehensive report as a basis for further work; (2) to obtain, with or without the aid of an act of the legislature, the logs of the greatest possible number of wells in all fields affected, and to publish cross-sections and other data explaining underground conditions; (3) to trace as far as possible the responsibility for all occurrences of water in oil wells, and to discriminate between those subject to remedy and those that are beyond correction; (4) to analyze and determine the source of all waters, and all varieties of oil; (5) to formulate and publish plans for corrective work, and to urge these plans on individuals, local water associations, and county supervisors, and where these plans are adopted, to supervise the work as carried out, and direct it, as far as possible, into the most profitable channels; (6) to promote the formation of local water associations and assessment districts, and suggest such plans for these (in regard to organization) as seem most in keeping with local conditions; (7) to furnish detailed advice and instructions to individuals who wish to undertake correction work, but lack the engineering skill required.

This lays out a wide field for the institution which undertakes the work, and calls for considerable money, but in due time the necessary legislative action and funds could be provided, if the legislature and the public were adequately informed as to actual present conditions; and there is nothing in this list of duties which would not be feasible with a competent and single-minded man working sincerely to this end.

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Hydro-Electric Power Plant at Cordova, Alaska

By ELY C. HUTCHINSON

ALASKA is distant, and not long ago those who ventured far from the beaten path expected to live under trying and adverse circumstances. Among other hardships was the necessity for spending the hours of darkness with only such light as could be obtained from candles and lamps. The pioneer of today enjoys the luxuries of the telephone, the moving-picture theatre, electrically lighted streets and dwellings, and in fact all other things which electricity has brought to modern life. The cities and towns of Alaska, remote as they may be, are in no wise behind in this phase of their civic development. The citizens of Cordova, with those of other progressive towns, point with pride to their city as one which possesses all the erstwhile luxuries that have now come to be rated as necessities.

Cordova is on Prince William Sound about half way between Katalla and Valdez. The growth of the city has been rapid since its choice as the deep-water terminus for the Copper River & Northwestern railway. It is also probable that Cordova will be the site eventually of smelting and refining plants for treating copper ore from the interior. Naturally a city with the great opportunities to which Cordova can look forward, has been and will continue to be the mecca for those who desire to share in the prosperity which attends the opening and development of new country. The city has already attained considerable size, and the requirements of the people in the matter of light and power were among the first of the commercial enterprises to be given consideration.

An available water-power site was filed upon some five or six years ago, and finally passed to the Cordova Power Co. The water rights secured are within easy distance of the city proper, and a sufficient quantity of water is assured for the development of electrical energy the whole year except in the event of unusually severe winter conditions, during which time steam is used as an auxiliary. The hydro-electric development determined upon after a full analysis of conditions consists of two 125-kw. water-wheel driven generators, one of which was put in immediately, with dam, pipe-line capacity, and power-house space, sufficient for a second unit when necessary. The plant has now been in successful operation for four years and provides fully for the needs of Cordova in the matter of light and power.

In the construction of the dam, economy required that the materials used

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be obtained locally as far as possible. For this reason, and as both timber and rock were available in ample quantities, a rock-filled timber crib-dam was constructed. Fig. 1 illustrates the downstream and Fig. 2 the upstream side. In the construction, the only concrete used was that in the dam-toe foundation, which was 6 ft. deep, and upon which the timber crib-work was built. The dam, at the base, is about 80 ft. long and 80 ft. thick. It rises to a height of 41½ ft. and tapers to a thickness of 10 ft. The crib-work slopes inward, approximately the same amount on both upstream and downstream sides. The length along the crest is 130 ft., and it will be seen from Fig. 1 that a plank-lined spillway is provided at the crest and to one side for the purpose of carrying the overflow. The upstream side is made water-tight by means of a double facing of 3-in. planking. The water outlet from the dam and the intake to the pipe-line, is placed in the base, and is arranged with a suitable taper inlet with head-gate and air-vent, connection being made to a 30-in. wooden stave pipe-line. The entrance to the pipe-line is protected from foreign material, and the intake is placed well below the surface of the water to avoid difficulty from slush ice or anchor ice.

FIG. 1. DOWNSTREAM SIDE OF DAM, SHOWING SPILLWAY AND PIPEHEAD.

The pipe-line is of 30-in. diameter and is of wooden stave construction throughout. It is 1355 ft. 6 in. long. Bands were spaced according to the varying pressure under which the pipe operates, the maximum gross head being 156 ft. An excellent idea of the country through which the pipe was

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laid and some of the engineering difficulties encountered in construction work may be obtained from Fig. 3. The line is laid on an easy grade, and abrupt bends and curves were carefully avoided. In one instance, however, a compound curve with a 66-ft. radius was necessary. At another the pipe-line was carried over a gulch upon a trestle 120 ft. high and 150 ft. long.

In the consideration of the proper type of water-wheel equipment for the plant, note had to be taken of the fact that during the cold season the flow becomes much reduced. In consequence there is a season each year during which the greatest possible economy of water consumption is of paramount necessity. During the cold season it was also especially desirable to eliminate, as much as possible, danger from fine ice particles entering the nozzle and becoming clogged, and thus endangering the continuous operation of the equipment. These conditions were successfully met by the use of a double nozzle, the upper jet or vent of which is provided with a hand-operated needle, and the lower vent of which is of the open-stream construction. This combination has many advantages. During times of ample water-supply the needle nozzle may be operated fully open and in conjunction with the lower nozzle; this permits development of power to the maximum capacity of the generator. As the cold season comes on and the water-supply gradually decreases, the needle nozzle may be gradually closed so as to keep the combined water discharge from both nozzles just equal always to the water-supply. This means that there will be generated at all times during the decreased flow the greatest possible amount of power.

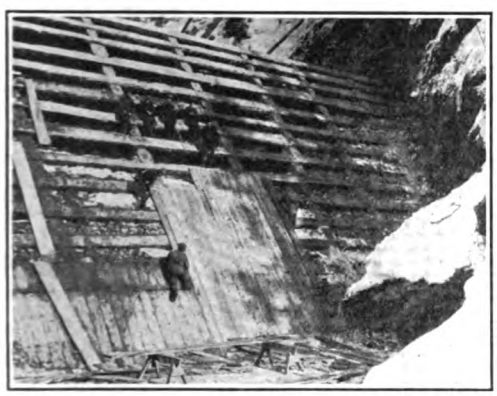

FIG. 2. UPSTREAM SIDE OF DAM, SHOWING METHOD OF CONSTRUCTION.

FIG. 3. WOODEN STAVE PIPE CARRIED ON TRESTLE AND AROUND CURVES.

At such time as the available supply of water reaches the point where it is one-half, or less than one-half of the flow required to operate the generator at its full capacity, the needle nozzle may be closed entirely, and the lower, or open-stream nozzle only allowed to

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remain in use. This lower nozzle will permit the ready passage of such small ice particles as might otherwise clog a nozzle of the needle construction; and at the same time the form of the stream delivered to the water-wheel will be maintained in its normal size and shape with relation to the water-wheel buckets. For this reason the half-load efficiency of the water-wheel will be much better than could be obtained through the use of a single nozzle of the needle construction, which, if it were used, would result, in times of low water, in an abnormal relation between stream diameter and size of bucket.

The water-wheel is designed for the development of a maximum power output of 200 hp. under 148-ft. effective head, and at a speed of 277 r.p.m. for a direct-connected, 125-kw., 2300-volt, 3-phase, 60-cycle generator. The main shaft, as well as its supporting bearings with soleplates, were supplied by the water-wheel builder, the shaft being extended from the main bearing into the water-wheel housing, wherein the wheel is directly mounted upon the extension, thus making what is termed a single overhung water-wheel equipment. The outboard end of the shaft is also extended and a driving pulley is mounted upon same for belt connection to the exciter, which is of 9 kw. capacity, operating at a speed of 750 revolutions. The bearings are of the highest type of construction, being of the ring-oiling, ball and socket type, with the barrels made separate from the cap and pedestal and resting in concave seats.

The speed regulation is provided for by means of a Pelton oil-pressure governor used in conjunction with balanced deflectors or hoods, the action being such that a decrease or increase of load upon the water-wheel will, through the governor, cause the deflectors to be thrown into or out of the respective streams of the double nozzle. This action results in a control of the quantity of water which reaches the wheel buckets to correspond with the load being carried at any particular time. As there are no storage facilities at the dam, this type of speed control is satisfactory. It is also simple in its construction and requires little for maintenance.

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Protecting Pipe-Lines Against Alkali

By C. P. BOWIE

MOST of the larger oil pools so far developed in the state of California lie in the arid districts. In the construction of pipe-lines through these districts, and leading from them to the sea-coast, one of the most serious problems the engineer has to solve is the question of an adequate protection for the pipe against alkaline soils. In the San Joaquin valley, through which the majority of these lines pass, the total alkali salts in the soils range from 0.05 up to 5%, and the average composition of these salts in the soils is about as follows:

	Per cent.
Potassium sulphate	11.28
Sodium sulphate	19.48
Magnesium sulphate	2.89
Sodium chloride	23.03
Sodium carbonate	40.96
Sodium phosphate	2.08
Sodium nitrate	0.28
	100.00

In many places the percentages of chlorides and sulphates are much higher than shown. In such soils, steel pipes 5/16 inch in thickness, although originally protected with three coats of asphaltum paint, have corroded so badly that pit-holes have developed, extending entirely through the pipe in three years time. If the life of a pumping system be taken as 20 years, and the cost of the pipe installed in the system as 40% of the total first cost, it is obvious that a protective coating, which will triple or even double the life of the pipe through bad territory, becomes an important factor.

Working along these lines, a number of coverings have been brought forward. Various kinds of asphaltum paint have been used, but, so far at least, without any marked degree of success. Crude oil has also been applied by covering the pipe after it has been lowered into the ditch to a depth of six inches or more with the oil, and then immediately filling in the ditch with earth. This method is only partly successful for the reason that if the soil is at all sandy the oil soaks into it, and in time almost entirely disappears from the vicinity of the pipe, leaving the metal quite as badly exposed to the alkali as before the application. Quick-setting bituminous enamels, which can be put on in a layer 1/8 to 1/4 inch thick, bid fair to give results. However, up to the present, these have one serious drawback, in that they cannot be successfully applied to a moist pipe or to a pipe having a lower temperature than 60°F., because the enamel, although it is put on at a temperature of approximately 200°F., is chilled so rapidly that it hardens before it can be spread. The action of the mop with

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which it is applied is merely to roll it into a myriad of balls or globules which do not stick to the pipe at all but fall to the ground. This not only causes a great waste of material, but is apt to leave many small portions of the pipe, especially on the under side, wholly unprotected even though several coats of enamel are put on. This difficulty can be largely overcome by applying the enamel in warm dry weather only, or to pipes through which warm oil is being pumped. There are no lines in this state which have been covered by this process and allowed to remain in the ground for any great length of time. One line passing through slightly alkaline territory, which was covered in this manner about two years ago, was found to be in excellent condition upon a recent examination.

The method of covering most extensively used, and perhaps the most successful one, is that employing especially prepared roofing papers. The papers commonly used are those made from ordinary deadening felt run through a mill in which the felt is plunged into a number of successive baths of hot asphaltum and rolled hot and under pressure after each successive bath until the fibres of the paper are thoroughly impregnated with the asphaltum. Just before entering the last set of rolls the paper is sprinkled with either mica or soapstone, which mineral, while it no doubt adds somewhat to resistance against the attack of chemicals, has for its principal function the quality of affording a means of keeping the paper from sticking in the roll in hot weather. Asbestos papers, prepared somewhat in a similar manner to the felt papers, have

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also been used in a number of places.

These papers are applied to the pipe by two methods, known locally as the 'spiral wrap' and 'longitudinal lap.' The spiral wrap, which is in most cases the most efficient method, consists of applying the paper to the joints between collars by wrapping it around the pipe spirally. For this purpose, the paper is cut in the mill into rolls of the desired size, varying from 3 to 12 inches in width, and containing from 50 to 100 ft. in length as best suits the diameter of pipe to be covered. The pipe is covered immediately after being screwed together by the tong gang and while still on skids over the ditch. It is coated with hot asphaltum and the wider strips wound on spirally before the asphaltum has had time to set. The crack which is left between each wrap of the wide strip is then coated with the hot asphaltum, and a batten, or 3-in. strip, wound on to cover it. The asphaltum used is a thin grade of the ordinary refined product, and is applied to the pipe at a temperature of about 200°F., and is of such a consistence that it will not set for about five minutes after application. If, due to climatic conditions or variance in the different shipments, the asphaltum sets too quickly, a so-called flux, which is simply a very thin grade of asphaltum, is added. It is usually the practice to ship one barrel of 'flux' to the field for every 60 barrels of asphaltum. At the joints 3-in. strips stuck together with asphaltum are wound around the pipe on either side of the collar until a shoulder is built up flush with the outer circumference of the collar. The sleeve and shoulder thus built up are then coated with hot asphaltum, and the whole covered with a 12-in. strip of paper. Besides being stuck to the pipe with asphaltum, this last strip is bound on with wire, as are also the ends of the paper where it is wrapped spirally. If this is not done, the ends will curl up and allow dirt to get between the paper and the pipe after the pipe has been lowered into the ditch, and before the back-filling has been done.

LONGITUDINAL WRAP; TWO JOINTS COVERED AND MEN READY TO COVER A THIRD.

SPIRAL WRAP; COVERED PIPE READY TO BE LOWERED INTO THE DITCH.

The longitudinal lap system, which to the present time has been much more

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extensively used than the system just described, consists (as the name implies) of wrapping the paper longitudinally around the pipe. The paper is delivered in the field in rolls, about 6 in. wider than the circumference of the pipe to be covered, each roll containing approximately 72 lineal feet. Two men go ahead of the paper gang and measure up each joint of pipe between collars and cut the paper into the desired lengths.

In applying the paper to the pipe, undoubtedly the best method is first to coat the pipe with hot asphaltum as previously described; then to wrap the sheet of paper around the pipe and stick down the lap with hot asphaltum. This, however, is not often done when covering lines where the oil passing through is to be heated, the supposition being that the heat of the oil (usually about 130°F.) combined with the pressure of the earth on the pipe after it has been buried will be sufficient to soften whatever asphaltum there is in the paper and form the necessary bond between paper and pipe to keep the water out. Without question, this supposition is correct to a certain extent. The paper, especially where a heavy quality is used, will undoubtedly adhere to the pipe in most places where it comes in contact with the metal; but it is to be noted that roofing papers applied to a pipe, while still on skids above the ditch, and allowed to stand in the sun for a few hours, will stretch to such an extent that the contact will be found to be on the upper circumference only, there being often as much as one-quarter of an inch of space between the bottom of the pipe and the paper. It is a serious question if this same thing does not occur when the heat from the oil first reaches the paper, even though the pipe has been lowered into the ditch and covered up. The paper, of course, does not bag uniformly as in the case above ground, but the surplus is taken up in wrinkles, and these wrinkles are very apt to be connected for the entire length of a joint of pipe. Should an injury occur to one of these wrinkles or a crack develop in it, which will undoubtedly be the case as oxidation goes on, it is not at all improbable that water, which would enter, would reach every place in a joint of pipe where the paper was not securely stuck on, and thus render the whole covering practically useless. Where asphaltum is used as a binder, the wrinkles that form will be filled, thus preventing the water from entering, even though the paper should in time crack at these points. Time alone, however, can solve this much-mooted question, since there are no lines in California protected in this manner that have been laid a sufficient length of time for these cracks to develop.

For covering the collars, the same method is used as with the spiral wrap, except that the binder is often omitted. This, it would seem, is even more serious than omitting the binder from the main body of the pipe, since it gives the water a chance to get between the paper and pipe through the ends of the wrinkles.

Whether a binder is used or not, the lap should always be made on the top of the pipe with the outer portion of the lap looking down, and wires should be placed about every sixteen inches. This is necessary to prevent the paper from being pulled away from the pipe by its own weight before it can be lowered into the ditch and covered.

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Mechanical Handling of Heterogeneous Merchandise

By LELAND S. ROSENER*

TELPHERAGE, a system of handling materials by means of small trolleys running on overhead tracks, is employed by the wholesale grocery firm of M. A. Newmark & Co., of Los Angeles, in their new mushroom type reinforced concrete warehouse which was especially designed for the purpose. The telphers run on I-beam tracks attached to the ceilings through the various gangways. Connection is made between the different floors by four elevators, three of which are also provided with an overhead I-beam track. The loaded telpher can be run on the elevator and carried up to any floor or down into the basement where goods are to be stored. The elevators can handle a load of 7000 lb. at a speed of 50 ft. per minute.

The runway for the telphers consists of a 10-in. 25-lb. I-beam, supported at every panel by two 9-in. 13¼-lb. channels, which carry the load directly to the columns and thus prevent any vibration of the 8-in. floor sash. Transfer at junction points is accomplished by a switch made of a 10-ft. section of track hinged at one end, rolling on large cast wheels in a circle at the other, so as to line up with the radiating tracks leading off at the different points. This switch point is easily moved from one side to the other by means of hand ropes. As a safeguard to keep the telphers from running into an open switch, a 1½-in. pin drops in front of the open track as the switch tongue moves away from a connection track. When the tongue connects with any track the pin is raised automatically so that the telpher passes under with good clearance. There is also a locking device which holds the switch tongue in exact alignment with the radiating track and which will not allow the tongue to move unless the hand rope be pulled.

The present plant has three telphers of 4000-lb. capacity each, with a maximum speed of 500 ft. per minute in either direction. Two trucks, 7½ ft. apart each, with four 7-in. wheels, are used to carry the telpher load on the I-beam. The drive motor is set on the front truck and geared direct to the wheels. Both trucks of the telphers are swiveled to enable them to go around curves of 10-ft. radius, which is the smallest used on any curves. There are trolley contact shoes on the front and rear trucks of the telphers, so as to give a continuous feed of current when the trolleys are broken at switch points and elevators. The contact is so good that no sparking takes place between the shoes and the rail. Current is fed to both of the motors from an angle-iron

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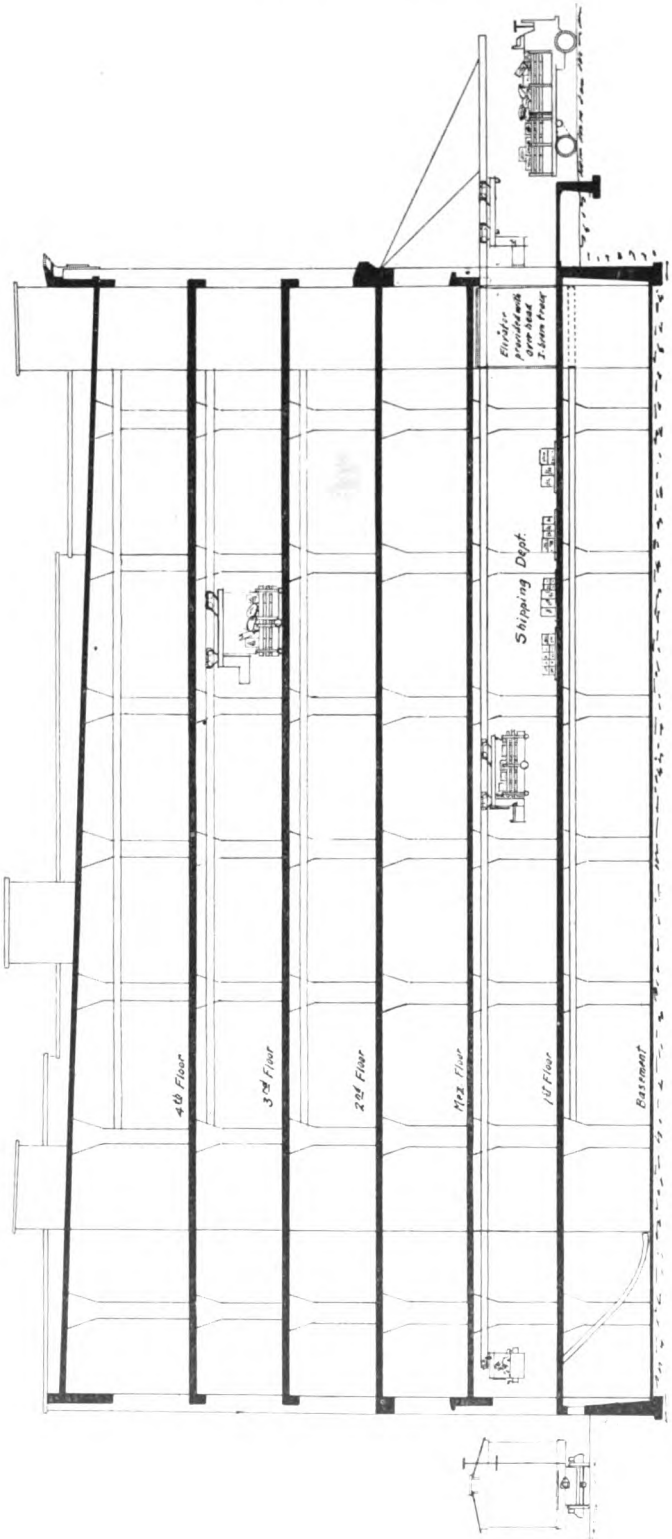

GENERAL ARRANGEMENT OF WAREHOUSE AND TRACKS.

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trolley 1¼ by 1¼ by ⅛ in. on each side of the I-beam track, and suspended therefrom. Direct current of 500 volts is used. The hoisting motor and gears are placed just in front of the operator's seat on the rear of the telpher. Here, also, are two speed controllers of the drum type for the hoist and the drive motors. The load is hoisted by means of two bars which are each attached to two ⅜-in. wire cables, and both are driven by the same motor at a hoisting speed of 50 ft. per minute and lowering speed of 80 ft. per minute, although these speeds are seldom reached, because of the short distances that the loads are raised or lowered. The load is held at any desired level by either of two brakes, a solenoid which releases only when the hoist motor is driven by current, and a mechanical friction brake which operates only on the downward direction of the load and by regulating the back-drive speed of the motor permits release to any desired degree. Either one of those brakes is sufficient to carry a load of double the capacity of the telpher.

TELPHER DELIVERING LOADED BODY TO AUTO TRUCK.

Three tracks on the first floor extend over the street for 27 ft., so that when an auto truck backs on the curb-line the telpher can run out over it and take off the load. Special bodies have been designed for these trucks. They are made in two parts, each 6 ft. 9 in. long by 5 ft. 8 in. wide, and are detachable. When the truck is backed into place under one of the telpher tracks, the telpher can be run out over it and the

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two bodies removed, one at a time, and taken in the building. If the body is loaded it is taken to the floor where goods are to be stored, and if empty it is sent to the reloading department on the first floor. In the meantime a second telpher places on the truck two bodies that have been loaded for city delivery or railroad shipment, and the truck is ready to be off. The removal of loaded or empty bodies and placing of filled ones on the auto trucks takes five minutes, on an average, as compared with over an hour consumed by the old method of loading hand trucks when they came in empty and had only to take on a load, or 1½ hours when they came in with a load for storage which had to be discharged before a load for delivery could be put on. This saving of automobile truck time in itself will pay sufficient interest on the cost of the entire system to justify its adoption. At the present time eight trucks of four tons capacity are used, but it is the plan of M. A. Newmark & Co. to add more motor trucks within a short time and to do away with teams entirely for delivery. Each auto truck is provided with two complete pairs of bodies.

Narrow flat trucks, for use on the floors, made small enough to go into the doors of box and refrigerator cars, are used for all work of unloading cars and moving goods to the different points in the building. These are made 4 ft. wide by 6 ft. 6 in. long, and strong enough to carry a load of about 5000 lb. On these trucks the end-stakes are permanent, but the side stakes can be removed, and are used only when loads of small articles or boxes which are apt to drop off are to be moved. It is seldom that these side stakes have to be used. There are hooks on the permanent end-stakes of the trucks for the bars of the telphers to catch. For moving around on the floor and running out from the cars, these flat trucks have two 12-in. wheels in the centre and a large castor at each end. It has been found that two men have no difficulty in moving a truck containing 4000 lb. of goods over the floor to any desired point. The truck bodies used on the autos are also provided with 12-in. side wheels and end castors, similar to those used on the small house trucks, so as to enable them to be moved some distance over the floor in making up orders, delivering goods to the floors, or moving a body out under the track where the telpher can take it. A pair of these bodies were tried on one of the trucks for six months before the building was completed, and it was shown that they stood the wear and tear much better than the bodies regularly furnished with the trucks.

Practically all goods are received in carload lots on the railroad track at the rear of the building. Parallel to this track and just inside the building is what is called the unloading telpher track. This runs the entire length of the building. The small house trucks are used for unloading the cars. These run into the cars and are loaded on the inside with about two tons of goods and then rolled by hand out of the car under the telpher track. The telpher then picks up the load and carries it to the floor where the goods are to be stored, leaving it under the track nearest the storage pile. From this point the floor-men move the loaded truck to the exact point where the goods are to be stored. With four men in the car and the telpher, a car can be unloaded and carried to the floor for storage in less than two-thirds the time required by the old method of using hand trucks, and also with a sav-

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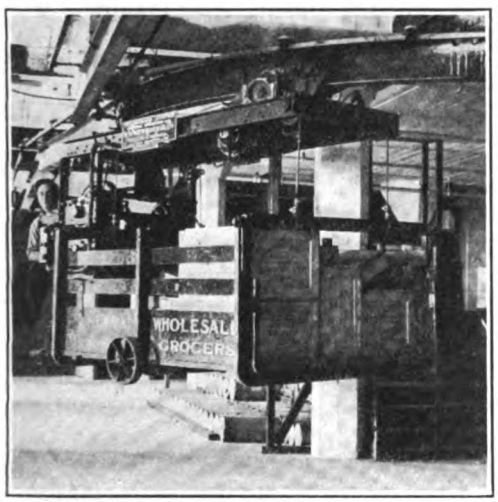
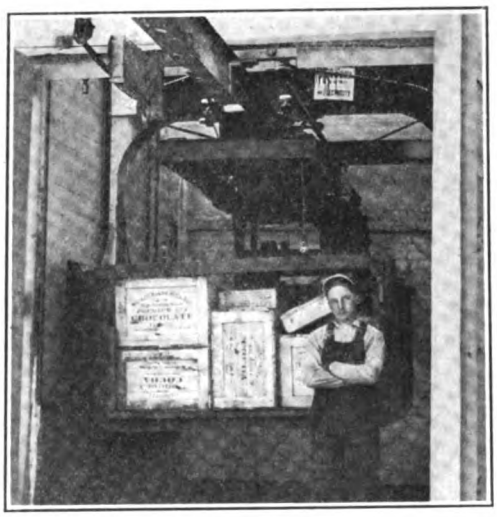
ing of the time of two men. The accompanying illustrations show the variety and size of loads carried by the telphers, and the method of handling to and from the auto trucks.

The two rear elevators are used almost exclusively for the unloading of freight, which is usually done in the morning. An average of about 200 tons of goods is received each day and unloaded by the telphers. In assembling the orders for outside shipment and city delivery, both spiral chutes and the telphers are used. When orders are for small quantities the goods are sent to the first floor through the spiral chutes and the orders assembled there. When the order is large enough to warrant it, the telpher is used to take a truck body directly to the storage pile on any floor where it can be loaded ready for the truck, and then brought to the first floor to be loaded on the first truck that comes in. Very often truck-loads of goods are loaded directly on the car at the rear of the building and are placed on the empty auto trucks by the telpher, the goods thus being handled but once. For small broken orders, which come down the spiral chute (these being the majority of the day's shipment) the empty truck bodies are lined up in front of the chute and the orders put in them and checked off long before the auto truck arrives. When the truck comes in, there is a load checked off and waiting, and it is only a matter of about six minutes to take the empties from the auto truck and put on the bodies previously loaded and ready for delivery. The record time for one truck from the time that it backed into the curb empty until it was gone again with a full load, was 3 minutes and 10 seconds. After a few months operation, there is no doubt that trucks will be loaded regularly in 4 minutes. The work of placing a loaded body on the truck and locking it is done entirely by the auto driver and his helper, so that no extra help is needed.



TELPHER AND AUTO BODY IN WAREHOUSE.



TELPHER ON ELEVATOR.

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The Engineering Digest

Credits Based on Contractors' Costs

IN spite of the large field for the placing of loans, and business offered by contracting work, there is a strong reluctance on the part of banks and business houses to extend credit to contractors, according to William H. Nye, writing in a recent issue of the *Banker and Investor Magazine*. Continuing, he says:

One of the reasons why it is not possible for the contractor to get credit on his future business is that of the lack of any standard condition in his business. A large amount of business may mean a huge loss instead of a profit. His great safeguard against a loss must be by keeping himself informed continuously about the financial result of his work. This is what the most progressive contractors are doing.

The job-cost systems used at the present time vary greatly. Some contractors keep accounts that show at the close of a job whether a profit or loss has resulted. Others have systems of cost covering each floor of a building or some similar physical unit of work. The contractors who are most accurate in their financial supervision of the work have reports that show daily cost in detail. Each item of the work, like masonry, structural steel, and carpentry, is divided into different classes. Units for each class are established; for brickwork it is a thousand brick, on steel the tonnage, and on carpentry different units to fit the class of work. These, as a rule, are exactly the items that the contractor estimated upon when he made his bid. Therefore, he has figures to show him how his work is progressing, and if there is any failure to accomplish the results expected he knows exactly at what points to bend his energies for a betterment in conditions.

It might be well to explain here just how these costs are obtained. For example, we will take the method employed by one of the concrete construction companies in New York. Its costs are based on the two items of labor and material which are kept separately.

The labor costs are found by an accurate system of timekeeping for payroll purposes. The job timekeeper is provided with a list of the various items upon which costs are to be kept. To facilitate this work and to insure its accuracy he is provided with a timebook ruled with columns for each of these items so that the hours that a man spends at each kind of work can be noted opposite his name or number. The timekeeper is required to check his men every two hours, and to show units of time as small as a half hour. As a rule a man is not on more than two or three kinds of work in a day, but to make a correct division of the time doubly certain the sub-foremen are required to be familiar enough with the work to inform the timekeeper just what his men have done for each two-hour period. A daily report of this labor distribution is sent to the office.

In conjunction with this time report a daily progress report, showing exactly the quantities of material used, the amount of each kind of form work placed, the yardage of concrete, and various other items of work completed, is sent to the general superintendent of construction. This report and the time report are used by the accounting department to obtain the unit of costs of the completed work. This cost record shows separately the time for mechanics and laborers on each item of the work. And these items, in their turn, are subdivided into classes of work, so that the final analysis shows to groups of two or three men just where the work is costing more or less than the estimate. From the daily reports sent to the general superintendent a material clerk

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checks the quantities of material used against the amount of work completed. From these two reports the executive branch of the firm can tell from day to day the exact financial status of the completed work.

Concrete work affords probably the best type of construction for a standardization of construction methods and a uniform cost system. The company referred to has so perfected its methods that the erection of the plant, the building of the form work, and the fabricating of the reinforcement are typical from job to job. This, of course, makes it possible to have an established set of items on which costs are to be obtained on every building. No such uniformity of methods of construction or cost systems is practical in the general contracting business where with a single firm the work may run from country residence work to bridges or tunnels in the course of a single year. The best way to take care of such a range of items is to have the time costs distributed to the items upon which estimates were made, and let the material costs cover some systematized physical unit.

There is no business where the men in charge of work have the opportunity for personal achievement equal to that in construction work. The whole field is open to them to show initiative, executive ability, and the power to get work from men. In business houses of established methods and fixed customs the superintendents or managers have certain routine methods to follow. On building work the superintendent, should he formulate some plan of construction that promises to achieve a better result, may put his plan into operation within a few minutes after he comes to the work. The knowledge that the costs are not meeting the estimate often brings about just such a radical change.

No better example of this can be cited than one instance that happened in the early days of concrete building construction. It was the custom at that time to build up a set of forms in the same manner that each story of a house was built. While the concrete that had been poured in these forms was gaining sufficient strength to allow the removal of the forms, another complete set of forms was built in the same manner for the next story. By the time that the second set of forms was filled workmen began removing the first set, board at a time, carefully saving the lumber to use for a third story of forms. Cost keeping at that time was not perfected to the stage that it is now, but it was evident that the money spent for carpentry labor and lumber was too great to allow a continuation of such methods at a profit. No criticism could be made of the manner in which the carpenters were supervised, for the foreman was getting full efficiency from his men. One thing did stand out—contractors were losing money—and that must be avoided in some way. With this necessity staring them in the face, all members of the organization started to devise a plan by which the cost on this work could be reduced. The first step was to build the forms in removable sections to save the expensive task of pulling the forms to pieces, and the more expensive task of rebuilding them. This single improvement so lessened the cost of form work that in spite of losses at the start of the job the final cost on form work showed a profit greater than had been expected in the original estimate. The far-reaching result of this step is that now concrete buildings of ten and twelve stories are built, using over and over the same forms with no reconstruction.

General contracting outside of the huge structural steel buildings in cities is very diversified and seldom admits of type work throughout a job. It is in this branch that initiative on the part of those supervising the work is most often demanded. The details of the work are so many and the length of time that a gang can be kept on one class of work so short that a very efficient organization of the work is not easily brought about. It is here that costs are most necessary. It is not uncommon, therefore, for daily costs to be made up on the job. This information from day to day enables the superintendent to know during the actual progress of the work on certain items whether he is running behind or making money And if he is running behind he has the opportunity of planning better methods for the work or discharging inefficient men before the work is completed.

In the matter of financing his work, however, the contractor finds a difficulty that he can accurately estimate. He goes to the banks and to the various supply dealers seeking credit on his various jobs. They, as a rule, will allow him credit on the assets shown by his books after careful examina-

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tion. They are loth to give further credit, even on the successful part completion of the work. It is the object of this article to show that extensions of credit from time to time on work that is progressing with financial success are justified.

The financial situation of the contractor is about as follows. On the tenth of each month he receives payment for 85 or 90% of the work that he has completed to the satisfaction of the architect during the previous month. In the case of large buildings where the architect keeps a close supervision on the work and where the amount involved is so great that a contractor must realize at once on his work, it is sometimes stipulated that payments shall be made not later than the fifth of the month following that in which the work was done. Such a favorable arrangement is the exception. More often the contractor finds his payment delayed beyond the agreed date, and this is especially true in the case of private work where owners are simply lax in their accounts. Taking the tenth of the month as the average date on which contractors are paid for their work, the whole account is carried for 25 days. During this time it is necessary for the contractor to devote a large part of his capital to meeting payrolls and to the payment of material bills to the exclusion of attempting other profitable work. It is especially at such time that contractors desire to obtain greater credit. Nor does this seem to be asking too much if it can be shown that the contractor has delivered, in the shape of building work already completed, a consignment of goods at a profit. In the various lines of manufacturing and distributing business the credit systems are so well standardized that such deliveries can be realized upon.

The average banker is not familiar with the details of the different kinds of business. His occupation is to loan money safely at a profit, and he naturally prefers to hold money rather than allow it to go for some unstable undertaking. From time to time he sees buildings undertaken at a loss by contractors, and knowing the many uncertainties of the building work, he tries to avoid advancing any more capital to contractors than he can see covered by tangible assets. But if he was convinced that a contractor had assets in the shape of completed work he might decide that a loan could be safely made upon that sort of an asset. The thing to do, therefore, is to provide some means by which a banker can be convinced that such work is really a safe asset. For a contractor to approach a banker for a loan with the detailed statement, based upon cost records, of certain work that had been completed at a profit, would scarcely result in convincing the banker that he should make that loan. This is because the banker is not familiar enough with contracting work to assume on his own initiative that such a statement covers the full expenditure that must be made on the so-called completed work, or that the statement in itself is correct. Were he to make a loan it would be because of his faith in the contractor rather than from any deep-seated conviction of security brought about by examination of the statement. Therefore, at present, the impersonal value of statements of costs is small in obtaining loans.

Now, to make statements of costs valuable in themselves, they must appeal impersonally to the banker or credit man, and the surest way to gain this impersonal value is to have the statements guaranteed by some reliable intermediary between the contractor and the lender. In certain lines of private banking there are houses that maintain a staff of competent technical men to pass upon the soundness of proposals for loans. Why would not some similar body be of advantage to general banking houses that make a practice of loaning to contractors?

In itself the establishment of a central board to which such banks could subscribe is not a difficult matter. This board should be composed of efficient engineers and estimators, well enough versed in the different kinds of construction methods to enable them to pass accurately on the correctness of contractors' estimates for bids, and on job costs. To further facilitate their work standard systems of estimating and cost-keeping could be established by this board. When a contractor has borrowed to the limit of his available capital, and has successfully completed work upon which he wishes to realize while awaiting for payment from the owner, let him present a cost statement of his completed work along with his estimate to the bank. The bank can then refer to this board for a verification of the statement. This board would examine the statement, check the actual work in place, and

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then report to the bank. Such a proceeding would enable the banker to get a clear and definite statement of the problem that he is dealing with.

The expenses of this board could be met by charging the contractor a stipulated examination fee, to be paid at the time the request was made. Such a charge would also tend to keep down the number of unsound requests, because no contractor would desire to pay a fee for the examination of a proposal that he felt was unsound and on which he could get no loan.

When the huge amount of money involved yearly in building work is considered, and it is remembered that the contractor is in a position where he is willing to pay the highest rates of interest to get ready capital, it seems that this proposel offers a field for loans of large amount at a profit much greater than is usual in the established lines of business.

Water Resources and Water Power of California

THE committee on conservation of the Commonwealth Club of California has been studying the natural resources of California. At the April meeting, reports from the sub-committee on water-supply and irrigation, of which C. E. Grunsky is chairman, and that on water-power, under the chairmanship of J. H. Wise, presented a report, of which an abstract follows:

Water Supply.—Out of the mining customs in the early history of California grew the necessity for protecting the appropriator of water. His rights so long as water was beneficially used were recognized against all the world except only the Government's paramount title as proprietor of the lands over which the streams flow. The custom of appropriating water has become subject to the rights of the private landowner who has succeeded the Government in the ownership of such lands. The paramount right of the landowner is defined as the riparian right of the common law; and the actual rights of the riparian owner are nowhere so clearly defined, either by statute or by court decisions, that a riparian owner can determine the extent of the use which he may make of the stream-flow. Adverse use of water for a period of five years may deprive a riparian owner of his right to interfere with such use. The statutes in force defining the rights of appropriators among themselves were passed in 1872. They are not complete nor sufficiently definite. The posting of a notice of a claim to water carries with it no right except, if proper use is made of water through works the construction of which was commenced within 60 days after the posting, that it fixes the date of the taking and thereby establishes a priority over all subsequent filings upon the same source of supply. The claims to water are recorded in the various counties. There is no state department of record. There is no supervision of the work of construction nor any relating to the extent of beneficial use. These matters are not found in any records unless they are brought to light in litigation. A state department is needed which will not only protect the water-right owner in his rights, but which will supervise the acquisition of rights in the water not already appropriated and beneficially used. Legislation of the needed character is under consideration by the State Conservation Commission and it is expected that the Commission's recommendations will be of such a character that a proper protection of acquired rights will result as well as a proper conservation with maximum use of the state's water resources.

An inventory of the irrigation resources of California is now being made by the State Conservation Commission. This involves a study of the vast areas of agricultural, grazing, semi-arid, and arid lands which will be benefited by the artificial application of water. It involves, too, a study of the available stream-flow and of other sources of water, such as artesian wells, and water development by storage, that is, by the conservation of a part of the flood-flow of the streams. These studies are being carried out in co-operation with federal departments, notably with the Water Resources Branch of the United States Geological Survey and the Irrigation Investigations of the Department of Agriculture.

Of 99,898,800 acres of land in California, 2,500,000 acres are swamp lands reclaimed and possible of reclamation, 13,500,000

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acres are valley lands, and upward of 4,000,000 acres are hill and rolling lands, which make a total of about 20,000,000 acres of arable land. Of 60,000,000 acres of forest, grazing, and mineral lands, 25,000,000 acres are in Government and 35,000,000 acres in private ownership. The bare mountain ranges and desert areas aggregate about 20,000,000 acres. According to the census of 1910, the improved area of agricultural lands was then 11,380,000 acres, of which 23.4%, or 2,664,104 acres, was irrigated in 1909. There were 3,619,378 acres under existing irrigation canals in 1910 and projects completed or projected covered a total area of 5,490,360 acres.

Large volumes of water annually flow to waste and can be in part conserved by storage. Due to favorable topographic and climatic conditions, nature holds back vast quantities of the winter precipitation in the high mountains in the form of snow. The melting snow keeps the rivers relatively high at the time, March to June, when water is most needed for irrigation. Larger diverting canals and larger experience by the irrigator will lead to more effective use of the natural stream-flow, particularly in central and northern parts of the state, where the value of irrigation is only now beginning to be fully appreciated. Where the supply of water is inadequate it must be conserved by reducing waste. Where the supply is abundant excessive irrigation should be checked to prevent permanent injury to the arable area. Data relating to the water supply of California cities and towns are being collected by the State Board of Health. The facts relating to the financial operations of municipally owned water works are being collected by A. B. Nye, state controller. Under its enlarged duties as a public-service commission, the Railroad Commission will come into the possession of data relating to many of the privately owned water works of the state. All the material thus collected should be made available by publication in systematized form—perhaps, for the present, best by the state controller.

Laws recently enacted permit municipalities to make appropriations of water for the future necessities, and they need develop only such supply as is required for immediate use. There is a strong tendency toward municipal and away from private ownership of the water works, particularly in the larger cities of the United States. In California, too, there is a tendency toward municipal ownership. In this state 64 incorporated towns own their water works, 127 are supplied by public-service corporations, and 56 places, not incorporated, necessarily have privately owned water works. Privately owned water works may be acquired under the right of eminent domain when municipal ownership is determined upon. By recent legislation water districts may be formed. A number of municipalities, and adjacent territory, may, after being duly organized, construct or otherwise acquire water works. As adopted at the regular session of the legislature in 1911, 25% of the property had to be represented on a petition for a water district. The law was so changed, at the subsequent special session of 1911, that 10% of the voters could compel the calling of an election. The first district proposed, in Marin county, will be voted on within a few months. The State Board of Health should examine into the sanitary condition of the water supplied by privately owned and by municipally owned water works and should be given adequate power to enforce measures for safeguarding the purity of the water.

The committee recommends that a comprehensive water law should be enacted along the general lines of such laws adopted in the various Western states, covering: the definition of natural water supplies and general principles relative thereto; the classification of water rights of every nature and a definition of the rights of the owners in the various classes and of the classes in their relation to each other; the creation of an administrative system, including a water commission; the administrative determination of existing water rights by the water commission; the establishment in court of the water rights after the commission's determination; the supervision of the diversion of water from the sources of supply; and the acquisition of permits for making new appropriations. It also recommends that special funds be granted to the State Board of Health so that a full and systematic study of the water works of this state may be undertaken and maintained and the information secured thereby published in such fashion as shall give to the people of the state the full benefits of such investigation; and that the State Board of Health be empowered and be granted funds to carry out a systematic and definite program of examination into the

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sanitary character of the various water supplies of the state.

Water Power.—A compilation of available reports and data concerning the water-power resources of the state of California indicates the possible development to be approximately 6,593,000 hp., of which 4,872,000 lies within the national forest areas and is under federal control, and 1,721,000 hp. lies outside the forest reserves. These figures are the ultimate development, and it should be borne in mind that a large percentage is uneconomical or prohibitive with the present cost of fuel or steam electric power. California has in active operation to date about 401,000 hp. and is second only to the state of New York with the Niagara Falls as a very large centralized source of energy. Of this state's present development, 173,000 hp. is under federal control and 228,000 hp. lies outside the national forest areas or is on patented land within the reserves. That active development is contemplated is shown by the fact that district No. 5 of the Forest Service, which includes California and western Nevada, has issued to date (March 1) 92 permits, with an aggregate of 981,000 hp., which indicates at least that the requirements of the Forest Service have not had a retarding effect.

A true conservation policy requires a rapid development of the hydro-electric resources, which, fortunately, do not become depleted through use; other natural resources are thus conserved, most of which decrease in a direct proportion to their exploitation. The committee, therefore, recommends a liberal policy, such that capital will be attracted and the water-power development will proceed with the progressive demands of the state, and at the same time the state retain its vested rights and properly regulate the power developed. These objects, it is thought, can best be served by legislation outlined as follows:

1. Appropriations for power purposes should not vest in the appropriator a perpetual right in and title to the use of water.

2. A lease, indeterminate in duration, should be granted, with general conditions fixed from the beginning, and should be subject to the rights of the state to require that the works be properly maintained; that they be operated to a reasonable percentage of full capacity and with reasonable continuity, on penalty of forfeiture of the license; and should be subject to the right of the state to regulate the rates and character of the service. The works should be subject to purchase at any time, at an appraised valuation, either by the state, by a municipality, or by a publicly organized water or power district. Condemnation proceedings should not be required, but upon vote to purchase in the manner prescribed by law, the Railroad Commission should be directed to appraise the value of the works to be purchased, and the utility should be required to make the sale upon the tender of the appraised valuation, subject to the usual right of appeal to the courts from the valuation as fixed by the Commission. The appraisal should determine the physical valuation of so much of the works as are used and useful in the business of the public utility, should allow for reasonable promotion expenses, and should include capitalization of interest charges during construction, but should not include any valuation for the license or any other franchise granted by the state or local authority unless a purchase price has been paid therefor. Capitalization of deferred earnings should not be included in the valuation but in lieu thereof, a bonus should be paid in the form of a percentage of the appraised valuation, such percentage to be in inverse proportion to the time that the license has run.

3. Licenses should not issue as a matter of right to any one who may apply therefor, but the law should provide that the license should not be given (*a*) if there is a conflict with a prior application or license; (*b*) if it is patent that there is no water subject to appropriation; (*c*) if the applicant fails to comply with the regulations made in pursuance of law.

4. Licenses should not be transferable prior to completion of the works, except upon the specific approval of the administrative board.

5. Licenses should be subject to cancellation for non-use for the purpose for which the license was issued, also for violation of the essential terms of the lease or of the law under which the lease was issued.

6. Before granting a license, maps, plans, and other data should be required in sufficient detail to permit of determining (*a*) whether the site will be completely developed, (*b*) whether the structures will be safe, (*c*) whether they are so designed as to make an economical use of the water.

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7. It is the opinion of the majority of the committee that no charges, other than filing fees, should be required for the use of water-power sites or water rights, and that these fees should be merely sufficient to cover cost of administration.

The Diesel Oil Engine

IN a recent address by Rudolph Diesel, before the Institution of Mechanical Engineers at London, it was stated that as a result of experiments covering a period of over 14 years, the thermal or indicated efficiency of the Diesel engine of today has reached 48%, and in some cases the brake horse-power output has reached 35% of the heat value of the fuel. He showed by diagram the heat utilization for one brake horse-power hour in each kind of prime mover known today. According to it, the steam-engine with exhaust required 7000 to 10,000 heat units; the engine with superheated steam and condensing steam-turbine required 4000 to 7000 units; the gas-engine with producer 3000 to 3600; the gas-engine without producer 2300 to 2600; and the Diesel motor 1850 to 2000. In the large machinery hall at the Turin Exhibition, a steam-turbine and a large Diesel engine, both made by Franco Tosi, of Milan, and set up on the same stand, were worked together with the same liquid fuel. The boilers belonging to the plant were fitted with Korting nozzles for burning crude oil. For the working of the steam-engine the whole boiler plant, with its chimney, fuel supply apparatus, purification plant for feed-water with feed-pumps, extensive steam-pipes, condensation plant with water-pumps, and an enormous water consumption, had to be provided, with the result that it consumed two and a half times the fuel per horse-power required by the Diesel engine standing beside it. The latter, being an entirely independent engine without any auxiliary plant, took up its crude fuel automatically and consumed it direct in its cylinders without any residue or smoke. It is not generally known that it is possible to burn fat vegetable oils and animal oils in the Diesal engine without difficulty. At the Paris Exhibition in 1900 there was shown by the Otto company a small Diesel engine which, at the request of the French Government, ran on *arachis* (earth-nut) oil, and worked so smoothly that only a few people were aware of the nature of the fuel. The engine was constructed for using mineral oil, and was then worked on vegetable oil without alteration. The French Government at the time thought of testing the applicability to power production of the earth-nut, which grows profusely in the African colonies. This project has not been developed further in France, owing to the changes in the Ministry, but Mr. Diesel resumed the experiments a few months ago, and has proved that Diesel engines can be worked on such nut oil without any difficulty. He published for the first time figures obtained by tests, which were: Consumption of earth-nut oil, 240 gm. (0.53 lb.) per horse-power hour. The calorific power of the oil is 8600 calories (34,124 b.t.u.) per kilogram, being thus fully equal to tar oils, and the hydrogen content is 11.8%. This oil was almost as effective as the natural mineral oils, and it could also be used for lubricating, the whole work being carried on with one oil produced directly on the spot. In this way the engines became really independent in the tropics.

Successful experiments have also been made in St. Petersburg with castor oil and animal oils, such as train oil, which has been used with excellent results. The fact that fat oils from vegetable sources can be used may seem insignificant today, but in the course of time such oils may become of the same importance as natural mineral oils and the tar products are now. Twelve years ago the latter were not more developed than the fat oils are today. In any case it is certain that motive power can be produced from the heat of the sun, which will always be available for agricultural purposes, even when all natural stores of solid and liquid fuels have been exhausted.

Mr. Diesel also mentioned that a double-acting, two-cycle, three-cylinder engine of 2000 hp. per cylinder, now being tested at Nurnberg, had already yielded considerably more than 2500 hp. per cylinder, so that an engine unit of this kind with six cylinders would give 15,000 hp. or 45,000 hp. for a vessel with three propellers; a result which

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overthrew the opinion still prevalent a few months ago that about 1000 hp. per cylinder was the maximum for Diesel engines. At present it is generally agreed that the four-stroke cycle engine from 5 hp. up to 600 may be regarded as the exclusive type for stationary plants; but in spite of its perfection it will probably not remain so much longer, in view of the development of the two-stroke cycle engine, and especially that of the double-acting type. The use of the two-stroke cycle engine has increased slightly, but it is to be hoped that it will be still further extended.

Although, it is true, this engine may never equal the four-stroke cycle engine as regards thermal efficiency, its initial cost is so much lower that its slightly higher fuel consumption will be more than counterbalanced by the greater interest and amortization on the higher-priced four-stroke cycle engine.

High Voltage Transmission

THE problems of high-tension transmission are many, and in a discussion on this subject contained in the March number of the *Proceedings* of the American Institute of Electrical Engineers, Charles P. Steinmetz says that we have reached transmission voltages at which the air begins to fail as insulator, and direct escape of electric energy into the air begins, as corona. This has led to the study of the law of corona, and the investigation is still being continued. The voltage at which a serious loss of power by corona begins depends on the size of conductor, the conductor spacing, and the air density. In proposed high-voltage transmission lines—above 80,000 volts—an investigation of the line conditions regarding probable corona loss becomes necessary. By the use of large aluminum conductors, possibly even with separate tower lines for each phase—to get very great distance between the phase conductors—we may be able to reach a quarter million volts as transmission voltage, and possibly still higher voltages by special designs of the line conductor, of which various forms have been proposed.

With the development of the grounded steel tower line construction with suspension insulators of high disruptive strength, with the grounded overhead wires protecting the line against the entrance of severe lightning disturbances, and the aluminum cell lightning-arrester protecting the stations, atmospheric lightning has practically ceased to be a formidable enemy of long-distance transmission; practically complete protection against atmospheric lightning can be afforded, and where lightning disturbances damage the transmission line the ultimate cause is usually either faulty or cheap line construction—usually the latter. Protection against atmospheric lightning is thus an economic question as to how far the value of the protected apparatus, and of the continuity of service, warrants the cost of lightning protective apparatus.

At the lower transmission voltages used before the development of the suspension insulator, the line was the weakest link of the transmission system, but it was believed that transformers could be built of any size and for any voltage. At 100,000 volts and over, a phenomenon makes itself felt, especially in large transformers, which is negligible at lower voltage: the distributed capacity of the high-voltage transformer winding. At lower voltages the transformer capacity is negligible, and the transformer thus becomes an inductive apparatus, and as such is impervious to all high-frequency disturbances, such as traveling waves, impulses, stationary oscillations, etc. High-frequency currents cannot enter the transformer, but produce high voltage between the end turns, protection against which is given by the high insulation of the end turns of the transformer, which has been used now for some years. Or the high-frequency disturbance, originating in the line, is entirely kept away from the transformer by the interposition of an inductance—a choke coil—between line and transformer.

At very high voltage the electrostatic capacity of the transformer becomes appreciable, and the high-potential coil of the transformer then represents a circuit containing distributed capacity, inductance, resistance, and conductance, just as a transmission line. The high-potential coil of a

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transformer differs materially from the transmission line in its constants. In the transformer the inductance is much higher, the capacity lower, than in the transmission line; the resistance is lower, and the conductance low, though not negligible; it represents the energy component of the capacity current, and is due to the dielectric losses in the insulating material of the transformer. The results of this difference in the constants is that transformer oscillations are higher in voltage and lower in current, and of lesser attenuation, that is, die out at a slower rate, than line oscillations; and cumulative oscillations, that is, oscillations of increasing amplitude, are more liable to occur in transformers than in transmission lines.

The high-voltage transformer thus must be considered as a circuit, capable of oscillating, just as a transmission line. That is, high-frequency oscillations may originate in the high-potential coil of the transformer, or oscillations originating in the transmission line may enter the transformer, and then, in passing over the transition point from line to transformer, increase in voltage while decreasing in current, by the transformation ratio of the transition point. The danger to which a transformer is exposed by high frequency disturbances from the transmission line, then, is not limited to the end turns only, but damage may be done anywhere inside of the transformer, wherever a wave crest forms—which depends on the frequency of the disturbance—and such destruction of an inside transformer coil by outside disturbances is not infrequent.

Inductance interposed between line and transformer then becomes a source of danger; while it keeps line disturbances out of the transformer, it also reflects disturbances which originate in the transformer, back into it, and thereby increases their voltage and their destructiveness. It thus becomes necessary to add to the inductance (the choke coil) a device which by-passes disturbances which come from the transformer, but does not allow line disturbances to pass into the transformer.

This leads into the field of protection against the phenomena of high-frequency disturbances, which now are the most serious, since, in the aluminum cell, a practically complete protection against transient high voltage has been developed, and which, with the increasing size of electric systems, are a constantly increasing source of danger to high-voltage overhead transmission systems as well as underground cable systems.

In high-voltage long-distance transmission lines of 150 miles or more, the capacity current of the line becomes considerable, and may, especially in 60-cycle systems, reach values higher than the full-load current. Even then, however, the capacity current is not as serious as may be expected, and its main objection is that it uses up generator capacity, that is, loads the generators with current which represents no power. Since it is due to shunted capacity, it may be compensated for by shunted inductance, that is, by connecting reactive coils of sufficient size permanently between the lines. This has frequently been proposed, and occasionally done.

Far more serious is the impairment of voltage regulation, incident to very long transmission lines. Assuming constant voltage at the generator terminals, the voltage at the receiving end of the line varies considerably between no load and full load—especially inductive load. Shunted reactance does not eliminate this, but while it reduces the no-load voltage by compensating for the capacity current and so eliminating the voltage rise due to this leading current, it lowers the full-load voltage and so leaves practically the same voltage drop between no load and full load. A line of quarter-wave length—800 miles with 60 cycles, 1900 miles with 25 cycles—transforms from constant potential to constant current. Hence, with constant voltage at the generator end, the voltage at the receiving end would rise to infinity at no load—that is, in practice, would be limited only by the resistance drop of the capacity current—and voltage regulation thus would be absent. Long before this condition is reached, voltage regulation is materially impaired. This phenomenon is most serious in the case of a short circuit on a system fed by the transmission, when the circuit-breakers at the end of the line open; in this case the load suddenly changes from overload to no load; the turbines, relieved of their load, momentarily speed up and increase the generator voltage; the capacity current of the line reacting to magnetize the generator field still further increases the generator voltage, and as at constant gen-

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erator voltage the change from full load to no load would cause a considerable voltage rise, with the increase of the generator voltage, this voltage rise at the receiving end of the line may reach 50 to 75% and more. This excess voltage is not a transient voltage, but is dynamic, and thus cannot be discharged by any protective device of necessarily limited energy discharge capacity, but can only be lowered by consuming power or lagging current, and even aluminum cells in this case, if not instantly relieved, are destroyed.

The most effective way of protecting against this sudden rise of dynamic voltage when the circuit breakers at the receiving end of the line open seems to be, not to open the circuit entirely, but arranging it so that an inductive load is thrown into circuit by the opening of the circuit breakers, sufficient to keep the voltage down.

Uniformity in Electrothermal Calculations

At the Boston meeting of the American Electrochemical Society in April, Carl Hering made pertinent suggestions for reform in the matter of electrochemical and electrothermal calculations. From the advance copy we make the following abstract.

In general, the simplification recommended is to use as practical units some decimal multiple of the corresponding absolute unit. A complete change, although desirable, would probably be too revolutionary to be acceptable. It is, however, possible to introduce at least a few easily made changes, and these alone will save many daily calculations. The first is to represent all power, no matter in what form it is, in terms of watts or kilowatts. Power is the rate of energy; it is energy divided by time. All forms of the generation, transmission, or consumption of power would then be expressed in the same unit, whether they be electrical, thermal, chemical, mechanical, magnetic, luminous, etc., or whether the transmission be by radiation, conduction, convection, or otherwise. No troublesome conversion factors are then required. This change is already being made in some cases. The generation, consumption, flow, rate of loss, etc., of heat in electric furnaces or other electrothermal devices will then be expressed in watts or kilowatts instead of calories per second, or b.t.u. per minute; also the rate of consumption or production of chemical energy in an electrolytic cell. This change is particularly useful in connection with electric furnaces and other large electrochemical and electrophysical apparatus.

The second recommendation is to represent and measure all forms of energy in terms of the watt-hour or kw-hour instead of in the two calories or b.t.u. This would mean that all specific heats, latent heats, chemical energy popularly known by the inappropriate name 'heats' of combination, etc., would be given in watt-hours or kw-hours instead of in thermal units, thereby again avoiding all conversion factors. Adopting the watt-hour or kw-hour for the practical unit of all forms of energy is not quite consistent with the absolute system, as this unit is not a decimal multiple of the absolute unit of time, the second; the adoption of the joule would be more rational. But in practice hours rather than seconds are dealt with, and to adopt the joule would mean repeated multiplications and divisions by 3600 to change back and forth to watt-hours or kw-hours. As electrical energy in commerce and industries is always expressed and measured in kw-hours and not in joules, it is much less of a change, and will actually save many calculations to use the watt-hour and kw-hour instead of the joule.

A third recommendation is to adopt a unit of thermal resistance. This will save much trouble in calculations of the flow of heat through bodies and in the transmission of heat in general, as in electric furnaces. Heretofore no unit has existed; the nearest approaches are a number of made-up units for the reciprocal quantity, thermal conductance, such as gram calorie per second per degree, and the b.t.u. per minute per degree. There are at least 54 such possible composite units of thermal conductance and therefore an equal number for resistance.

The only way to hope to obtain uniformity and general practice is to combine on a unit which is as rational as possible, is international, and which simplifies calculations as much as possible. The former is accom-

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plished by making it a decimal multiple of the absolute unit, and the latter by choosing that decimal so as to avoid even a decimal conversion factor as much as possible. Moreover, for probably by far the larger number of problems it is simpler to use resistances than conductances, hence it is better to define the unit of resistance and let the other be its reciprocal.

All the above are accomplished by a new unit of thermal resistance proposed by Mr. Hering some time ago and called thermal ohm, a name originally proposed by A. E. Kennelly, but for a unit of a different magnitude. If the Centigrade degree be the absolute unit, then the absolute unit of thermal resistance is that resistance which will cause an erg of thermal energy to be transmitted per second when the difference of temperature is one Centrigrade degree.

The thermal ohm is made one ten-millionth of this, hence it is that resistance which will allow one watt of heat current to flow when the temperature difference is 1°C.

If thermal resistances are expressed and measured by this unit, then the fundamental law of heat flow is exactly analogous to Ohm's law for electric flow; that is, if the flow of transmission of energy W is in watts, the temperature T in Centigrade degrees, and the resistance R in thermal ohms, then $W = T/R$; that is, the conversion factor then becomes unity, as it does in Ohm's law. For the few cases in which it may be preferable to use thermal conductances instead of resistances, the reciprocal of this value is recommended, and in order to conform with electrical practice, it is proposed to call this the thermal ohm.

A fourth recommendation is to urge the use of the Centigrade temperature scale to the entire exclusion of the Fahrenheit scale. It is much more international, and is the one used in the best tables of data.

The chief conversion factors to and from this simplified system are as follows:

Power:

1 watt = 0.238882 gram calorie second.
1 gram calorie per second = 4.18617 watts.
1 watt = 0.0568776 b.t.u. per minute.
1 b.t.u. per minute = 17.5816 watts.
1 kilowatt = 14.3329 kilogram calories per minute.
1 kilogram calorie per minute = 0.0697695 kilowatt.

Energy:

1 watt-hour = 0.859975 kilogram calorie.
1 kilogram calorie = 1.16282 watt-hours.
1 watt-hour = 3.41266 b.t.u.
1 b.t.u. = 0.293027 watt-hour.

Thermal resistance:

1 thermal ohm = 4.18617 gram calorie units of resistance.
1 gram calorie unit of resistance = 0.238882 thermal ohm.
1 gram calorie unit of resistance = reciprocal of gram calorie unit of conductance.
(A gram calorie unit of conductance is a conductance which permits a flow of 1 gram calorie per second per degree.)

Thermal resistivity:

1 thermal ohm, cm. cb. unit = 4.18617 gram cal., cm. cb. units.
1 gram calorie, cm. cb. unit = 0.23882 thermal ohm, cm. cb. unit.
1 thermal ohm, inch cb. unit = 2.54001 thermal ohm, cm. cb. units.
1 gram calorie, inch cb. unit = 2.54001 gram cal., cm. cb. units.
To reduce thermal conductivities given in b.t.u. per hour, per square foot, per inch thickness, per Fahrenheit degree, to thermal ohm, inch cube units, multiply the reciprocal of that number by 273.013.

Water Power Development in British Columbia

THE Canadian Commission of Conservation has supplemented its general report by a special volume devoted to water-powers. From this we have abstracted the following notes on the power situation in the Northwest.

The principal power developments in the vicinity of Vancouver are the North Arm and Stave Falls power plants. The former is operated by the Vancouver Power Co., a subsidiary company of the British Columbia Electric Co. It furnishes power for lighting and street railway service in the lower mainland of British Columbia, Vancouver, and

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the vicinity. The generating station is situated in the north arm of Burrard inlet, Buntzen lake being used as a reservoir. The operating head is approximately 400 ft. The water is diverted and carried through a tunnel 12,775 ft. long, which is stated to be the longest hydro-electric tunnel in the world. The present installation consists of four 3000-hp. and two 10,500-hp. generating sets. The Stave Falls plant is situated at the upper Stave River falls, the operating head being 100 ft. at low water and 120 ft. at high water. The quantity of water available is 300 sec.-ft., which will produce 28,000 electrical horse-power continuously and provides for a possible peak-load of from 44,000 to 48,000 hp. The erection of a dam 120 ft. high, at a water right owned by the company below the present plant, would permit of producing an equal amount of power. The present plant includes two 13,000-hp. turbines, direct-connected to two 7500-kw. generators. Power is transmitted at 60,000 volts, 35 miles to a receiving station near Vancouver, where it will be distributed at 2000 volts in Vancouver and surrounding towns.

Power developments in the vicinity of Victoria include the Gold Stream and Jordan River plants, both being operated by the British Columbia Electric Railway Co. The Goldstream plant is approximately 17 miles northwest of Victoria, the water being carried through a 33-in. diameter steel pipe 8000 ft. in length, from the watershed and reservoir to the power-house. The power-plant equipment consists of a 4600-hp. turbine, operating under the head of 650 ft., direct-connected to a 2900-kw. generator. The Jordan River plant is 45 miles northwest of Victoria, the water being carried from storage reservoirs by natural stream bed and wooden flume six miles long. The pipe-line is 9000 ft. in length, the operating head being 1150 ft. The power-house equipment consists of a 6000-hp. turbine, direct-connected to a 4000-kw. generator. The ultimate capacity of this development will be 24,000 horse-power.

There are many important power companies operating in the interior of British Columbia, including the West Kootenai Power & Light Co., which owns and operates the South Kootenai Water Power Co., the Cascade Water & Light Co., the Rossland Water & Light Co., and the Okanogan Water Power Co. These companies furnish power and light to Trail, Rossland, Grand Forks, Phoenix, Greenwood, and Boundary Falls, the smelters and mines constituting the largest consumers. Power-plant No. 1 is situated at lower Bonnington falls, about 18 miles from Nelson, and consists of three generators with a combined capacity of 3000 kw. Power-house No. 2 is situated about half a mile above No. 1, and while it has an ultimate capacity of 32,000 hp., the present equipment consists of two 5625-kw. generators. There is one 85-mile 60,000-volt, and one 50-mile 20,000-volt transmission line. Power-house No. 3 is situated at Cascade and contains three 750-kw. generators, 25 miles of duplicate transmission line to Grand Forks, Phoenix, Greenwood, and Boundary Falls, which are connected so that power can be supplied from Bonnington falls at 60,000 volts, or from the Cascade system at 20,000 volts. There are sub-stations at Trail, Rossland, Grand Forks, Phoenix, and Greenwood.

Heat Radiation From Condenser Water Reservoir

ACCURATE data concerning reduction in temperature of condensing water in reservoirs due to cooling effect of air and evaporation have been obtained by W. B. Ruggles in a series of tests taken at the mill of the Crescent Portland Cement Co., of Wampum, Pennsylvania, and were published in the April issue of the *Journal* of the American Society of Mechanical Engineers. The essential facts are summarized in the accompanying table.

The mill stands on a level plateau 110 ft. above the river, and as pumping from the river would entail considerable power expense, a dam was built 275 ft. long and 18 ft. high, which impounds about 6½ acres of water. The water flows from the condenser through a tile pipe about 50 ft. long into the east side of the reservoir about 100 ft. from the north end. A dike was built south of this toward the centre of the reservoir and then north nearly to the end, thus compelling the circulating water to flow up and around the end of the dike and down

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toward the dam, a distance of about 1100 ft. before it reached the intake to the power-house. Water to supply the reservoir is pumped from the river at the rate of 2324.25 gal. per minute by a 150-hp. electrically-driven centrifugal pump, 8 hours pumping per week being sufficient to compensate for evaporation and seepage in the reservoir. The average horse-power developed in the engines during the test was 2446 and gave a power consumption per barrel of cement produced of 0.8 hp. Details of these tests are given below.

Area of reservoir, 288,000 sq. ft.; average depth of reservoir, 5.36 ft.; capacity of reservoir, 1,53,680 cu. ft. = 96,480,000 pounds.

Log of Tests.	Week ended May 7, 1911.	Week ended July 12, 1911.	Week ended Nov. 27, 1911.
Amount of water pumped from river, lb.	10,458,956	29,050,875	4,648,140
Average temperature of river water, deg. F.	57.5	77	36
Average temperature of intake to power-house, deg. F.	72.75	91.43	61.71
Average temperature of tail water from condenser, deg. F.	101.36	129.43	90.71
Average temperature of reservoir, deg. F.	87.05	110.00	76.71
Average temperature of air, deg. F.	51.00	78.43	33.30
Average difference of temperature between water and air, deg. F.	36.05	31.57	43.41
Change in temperature of reservoir during test, deg. F.	0.25	7.00	2.00
Three 26 by 52 by 36-in. compound condensing engines, hp-hr.	397,807	411,320	426,936
Two 12 by 21-in., 11½ by 24 by 24-in. air-compressors, hp-hr.	46,536	46,536	46,536
Average vacuum at 30 in barometer, in.	26.4	22.2	26.6
Average water consumed by engines, per hp. per hr., lb.	14.46	15.64	14.41
Average water consumed by compressors per hp. per hr., lb.	18.85	20.12	18.83
Steam condensed by engines, lb.	5,752,289	6,433,045	6,145,148
Steam condensed by compressors, lb.	877,204	936,314	876,273
Latent heat of steam condensed, lb.	1,024.7	1,007.1	1,026.0
Heat delivered to reservoir by engines, b.t.u.	5,894,370,000	6,478,720,000	6,304,922,000
Heat delivered to reservoir by compressors, b.t.u.	898,871,000	942,961,000	899,056,000
Heat to raise river water to average temperature of reservoir, b.t.u.	309,062,000	958,679,000	189,226,000
Heat given up or retained in reservoir during test, b.t.u.	24,120,000	675,360,000	192,960,000
Heat reduction in reservoir due to rain, b.t.u.	21,630,000	56,700,000	46,200,000
Heat absorbed by air and evaporation during seven days, b.t.u.	6,438,429,000	5,730,942,000	6,564,509,000
Heat absorbed by air and evaporation per sq. ft. of surface seven days, b.t.u.	22,356	19,899	23,495
Heat absorbed by air and evaporation per sq. ft. per hr., b.t.u.	133.1	118.4	139.8
Heat absorbed by air and evaporation per sq. ft. per hr., per 1° difference, b.t.u.	3.69	3.71	3.22

It appears from the tests that under ordinary conditions, in the northern part of the United States with engines using 15 lb. of water per hp-hr. and a vacuum of 26 in., a reservoir having a surface of 120 sq. ft. per hp. would be ample.

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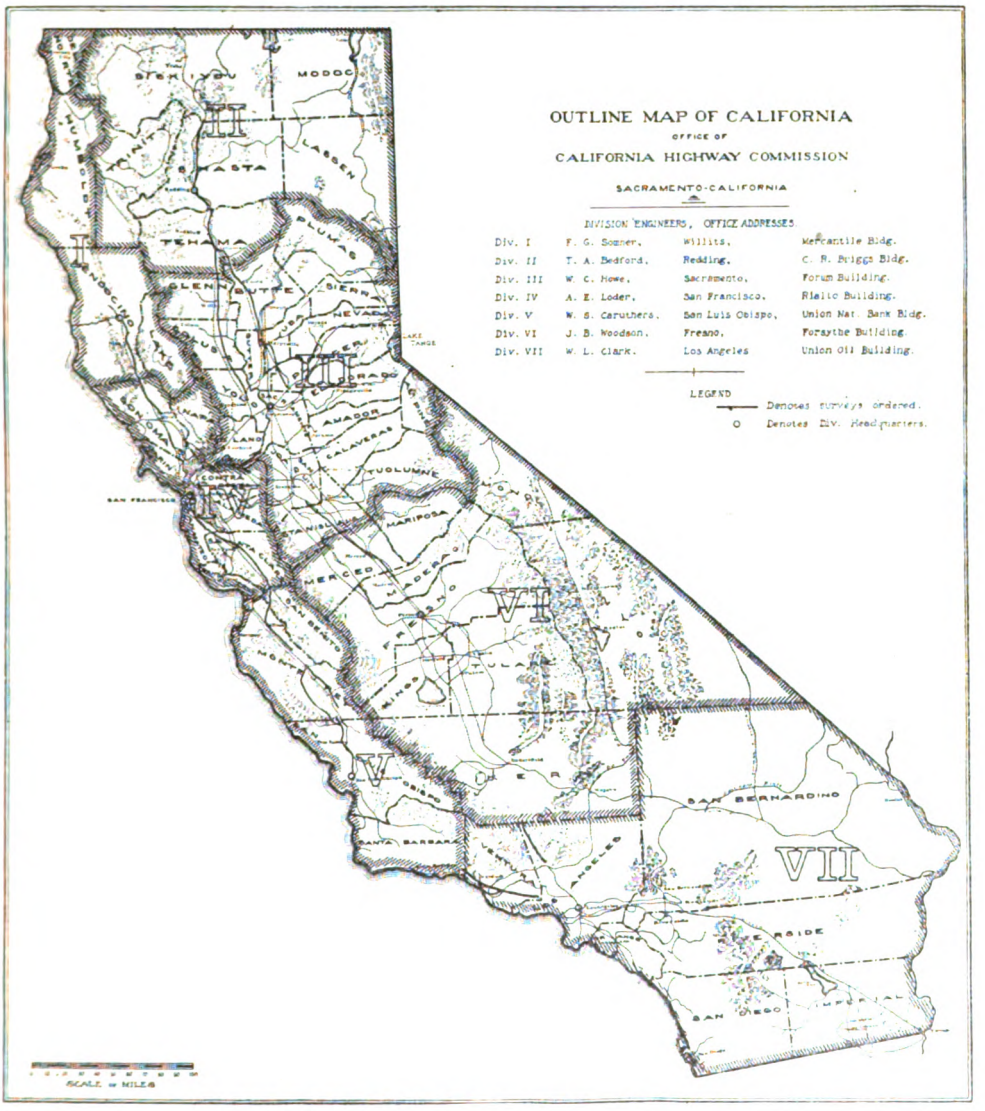
California State Highway Report

ORGANIZATION and progress of work on the state highway system is the subject of the first report of Austin B. Fletcher, highway engineer, dated April 1, 1912. The map of California above shows the various sections into which the state has been divided, with names and location of headquarters of the division engineers. A complete scheme of organization was first worked out with full provision for close control over all work.

For the purpose of making surveys, plans, and estimates, the routes enumerated below were selected by the Commission on January 25, 1912:

San Francisco to Oregon line (421 miles).



San Francisco to San Diego *via* Los Angeles (592 miles).

Sacramento to Oregon line *via* east side of river and Redding (344 miles).

Sacramento to Los Angeles *via* San Joaquin valley (445 miles).

Stockton to Santa Cruz *via* Oakland (133 miles).

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Sacramento to Woodland Junction (20 miles).

Tehama to Benicia (191 miles).

Hopland to Vallejo *via* Lake county (107 miles).

Los Angeles to Riverside (46 miles).

On its journeys of inspection the Commission went over nearly all of the foregoing routes. As nearly as can be ascertained from odometer readings and from maps, but without surveys, they aggregate 2300 miles, approximately.

The Commission on January 25, 1912, and later, has ordered surveys, plans, and estimates of highways aggregating about 850 miles in length divided as follows:

1. Beginning at the southerly boundary line of Mendocino county near Cloverdale, thence following the west side of the Russian river to Hopland, thence crossing to the east side of the river, passing through Ukiah and extending to Willits; approximately 41 miles.

2. Beginning at the southerly boundary line of Tehama county below Vina and extending northwesterly to Tehama, thence northerly and westerly through Red Bluff and Anderson to Redding; also a reconnaissance between Redding and Dunsmuir; also, beginning at the southerly boundary line of Tehama county near Orland and extending in a northerly and easterly direction to Tehama, passing through Corning; approximately 117 miles.

3. Beginning at Roseville, at its junction with the Auburn road and extending *via* Lincoln and Sheridan to Marysville; also, beginning at the southerly boundary line of Tehama county, below Vina and extending in a generally southeasterly direction through Chico and Yuba City to Marysville; also, beginning at the southerly boundary line of Tehama county near Orland and extending southerly and southeasterly through Willows and Williams to Woodland; also, beginning at the southerly boundary of San Joaquin county near Ripon and extending in a southerly and easterly direction through Modesto to the southerly boundary line of Stanislaus county; approximately 194 miles.

4. Beginning at the southerly boundary line of the city of San Francisco and passing through San Jose and Gilroy to the southerly boundary of Santa Clara county below Sargents; also, beginning at the northerly boundary line of Sonoma county near Cloverdale and extending south through Geyserville, Healdsburg, and Santa Rosa to Petaluma; approximately 120 miles.

5. Beginning at the northerly boundary line of San Benito county on the road between Gilroy and San Juan, thence extending in a general southerly and westerly direction to Salinas, thence southerly and easterly to Soledad, changing the line over San Juan hill so as to secure proper grades and alignment; also, a reconnaissance between King City and Bradley, having in mind a route on the east side of the Southern Pacific railroad between those places; also, a reconnaissance beginning at King City bridge and passing through Jolon and Pleyto to San Miguel; also, beginning at the northerly line of San Luis Obispo county near San Miguel and extending southerly, passing through Paso Robles, Templeton, Santa Margarita, and the Cuesta pass to San Luis Obispo; approximately 158 miles.

6. Beginning at the southerly boundary line of Stanislaus county and extending in a southerly and easterly direction through Merced and Berenda to Madera; approximately 51 miles.

7. Beginning at the westerly boundary line of Ventura county near Punta Gorda and extending by what is known as the Rincon road to Ventura, thence *via* El Rio and the Canejo Grande through Calabasas to Cahuenga pass; also a line passing through El Rio and Oxnard and extending to Canejo Grande in Ventura county; also beginning at the southerly boundary line of Orange county below San Juan Capistrano and following the coast *via* Oceanside, Carlsbad, and Encinitas to the northerly boundary line of San Diego city near Del Mar; also, a line beginning at Newhall in Los Angeles county and running *via* Castaic canyon and ridge to the southerly line of Kern county; approximately 166 miles.

But little or no survey work was begun until February 15, since almost none of the engineering equipment was received until after the middle of February. The survey parties were organized as rapidly as possible, due regard being given to the fitness of the men for the work, and by March 23 there were 25 parties at work. Reports from the field indicate that nearly complete surveys of more than 135 miles of road had been made by March 23 and that working drawings had been plotted by that date rep-

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resenting more than 40 miles of road surveyed. The cost of a typical survey camp outfit for six men, including horses, wagon, tents, camp and kitchen hardware, furniture, and instruments, has varied from $950 to $1000.

A number of the counties, through their representatives, voluntarily offered to provide free rights of way and build all bridges necessary for such state highways as might be located within their respective limits. These offers were so spontaneous throughout the state that the Commission addressed a communication to the boards of supervisors of all the counties, asking that official action be taken and agreements be made to furnish free rights of way and construct all bridges for all state highways through their territory.

The dispatch with which the boards of supervisors throughout the state are passing the necessary resolutions guaranteeing the rights of way and bridges has been remarkable and most gratifying. Many counties are already engaged in obtaining rights of way for routes which are only tentative, but which the county officials anticipate will be chosen as final routes.

International Engineering Congress in 1915

THE following memorial was prepared by delegates from the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Society of Naval Architects and Marine Engineers, American Society for Testing Materials, and Mining and Metallurgical Society of America, at a meeting held in San Francisco, January 15, and affords the basis of an appeal for funds now being made by the local committee.

Among the engineering feats that have characterized the last century and the years of the present thus far run, there is nothing that approaches in magnitude and boldness the construction of the Panama canal. When completed and in operation, its effect on travel, commerce, and navigation will be profound. As a factor in determining the character of the advance in civilization during the twentieth century, its influence cannot now be measured, but its potential importance is entering into all the arrangements for future commerce. It is a signal honor for the United States of America that it has been permitted to serve as the instrument by which this great engineering work is to be accomplished. Perhaps in no other way could this Nation have more significantly impressed its character on a work of world-wide importance. In this great achievement, no class in this country is more interested than engineers, who are proud of the men in their profession bringing this great enterprise to a successful completion. The determination to hold on the Pacific Coast an international exposition to celebrate the joining of the two great oceans has brought to the engineers of the West a stimulating sense of the importance of the work of the engineer as a factor in carrying forward the march of civilization, and, mindful of the inspiration and professional uplift to be derived from a concourse of engineers drawn from all parts of the world to one place and animated by one common purpose, they have committed themselves to the undertaking of bringing to the scene of this celebration representative engineers from the great engineering associations of the world in an International Engineering Congress to be held in San Francisco during the course of the Exposition. In the full realization that this can be accomplished only through the various national societies, acting in coöperation toward such an end, the representatives of such societies report the following plan:

General Outline.—The type of international engineering congress which this convention desires to recommend may be viewed primarily as a series of meetings of the various American national societies with the participation or coöperation of foreign societies of similar standing, held in one place and with such relation or sequence in time as may best serve the convenience of those desiring to attend. This type of Congress we believe to be the simplest in organization and the most practicable in its relation to the various interests involved. It will secure flexibility of general organization and, to the participating societies, the largest possible independence and responsibility, each

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in its own field of work. Having in view a congress of this type, the part which would be taken by each national society in its individual capacity may be outlined as follows: (*a*) It will issue in its own name invitations to the foreign societies with which it is most closely affiliated and will be primarily responsible for the duties of host to such as may accept. At the same time such invitation might naturally be supplemented, should the inviting society so desire, by a further official or formal invitation from the Exposition authorities through their special Commitee on Congresses. (*b*) It will in a similar manner invite, as it may desire, specially eminent foreign engineers to read papers or to take part in the proceedings. (*c*) It will be responsible for the procuring of papers, their examination, acceptance, translation where necessary, and printing previous to reading. In this manner each society, acting for itself and in its own field, will assume full responsibility for the scope and character of the papers which are presented under its direct auspices. (*d*) It will likewise assume responsibility for final printing and publication of papers with discussion, and as it chooses may effect such publication either as a part of its annual volume or as a separate publication. These various duties and responsibilities relate to the participating societies individually and are not shared with any other committee or body.

Scope of Congress.—This convention recommends that the scope of the proposed Congress, as determined by the number and character of the societies invited to participate, be determined by the seven national societies to which this report is primarily made, acting conjointly in such manner as may be hereafter determined.

Other Duties and Activities.—In addition to the preceding outline of suggested duties and activities inhering in the national bodies themselves, either individually or conjointly, there will be certain further general duties and activities which must be shared among the participating societies or delegated in some measure to a representative committee. Such duties may be briefly noted under the following three heads: (*a*) local committee activities; (*b*) general publicity; (*c*) social events, excursions, and like attention to foreign visitors. It is clear that in carrying to a successful issue an undertaking such as the proposed congress there will be required a strong and widely representative local committee. This convention recommends that the nucleus of such a local committee should consist of a local executive committee comprising three representatives from each of the participating national societies, such representatives to be appointed by the council or other appointing power of each society, having in view such nominations or suggestions from its local members or branch as they may desire for their information or guidance. The general duties of such a committee are sufficiently evident from its name. It will have no authority to speak for any national society except as it may receive direct authorization to do so. It will serve primarily as a link between the Exposition authorities and the various national societies and will in general endeavor to correlate all efforts and interests of a local character toward the success of the undertaking.

Program of Meetings. — Each society will naturally prepare and be responsible for the program of its own meeting. It will be desirable, however, to secure something in the nature of a program of meetings, simply to insure the entire series within a reasonable total time of perhaps 15 days, without lost time, and in such sequence or concurrence as shall be mutually most agreeable. Such arrangements would most naturally be made through the local executive committee acting as an intermediary between the various societies and the Exposition authorities, and as a general clearing-house for all such matters as may affect the various societies in a collective sense.

Joint or Mass Meetings.—While papers generally will be presented under the auspices of the society which has secured their preparation, it is not unlikely that it may seem desirable to hold certain joint or mass-meetings or assemblies at which distinguished foreign engineers or others may have the opportunity of addressing a larger audience than might attend the meetings of a single society. It may seem desirable to open the congress with some such meeting. Such details may readily be arranged by the suggested local executive committee which will act in this regard, as in all others, on behalf of such groups of societies as might desire to make such arrangements.

Publicity.—Regarding publicity, the local committee will naturally be expected to look

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after such part of this program as may relate to the Pacific Coast in general, California, San Francisco, and the officials of the Exposition itself.

In addition, each national society will naturally take such steps, both officially as a body and individually through its members, as may serve most effectively to bring the matter to the favorable attention of its own members throughout the country, and in particular to that of such foreign societies as it might naturally be expected to invite. Social events, excursions, etc., will naturally be arranged by the local committee, acting, however, in coöperation with the various national societies, and as their direct agent in the case of any special arrangements which they may desire to make.

Finance.—The various participating societies will naturally provide, each in its own way, for such expenditures as may be necessary to carry out its own individual part of the program as outlined above. In addition there will be need of certain general funds, especially for the activities of the local committee. This convention does not recommend any specific plan for providing such funds, believing that it may be safely left as a detail to be later determined, in case the proposed outline plan of organization secures general approval. For social events, excursions, etc., it will be necessary, presumably, to depend largely on private contributions. This also is a detail which is left for later consideration.

Time of Proposed Congress.—This convention has considered carefully the question of the time of year most suitable for the successful holding of a Congress such as that proposed, and begs to report that in its opinion the month of September (more exact dates to be later determined) will prove the most acceptable both as to climatic conditions and the general personal convenience of those who will desire to attend.

Assembly Rooms for Meetings.—This convention has received through representatives of the Exposition authorities, authorized to speak for its president and board of directors, full assurances regarding the adequate provision, free of all expense, of suitable assembly rooms, convention halls, etc., as may be required for a congress such as is herein contemplated. These assurances, in written form, are contained in a letter addressed to the chairman of this convention by the chairman of a special committee of the Board of Exposition Directors, fully empowered to give to this convention assurances regarding such assembly and meeting rooms, and regarding the cordial coöperation and support which the Exposition authorities will extend to such an Engineering Congress. In conclusion, this convention desires to report and to recommend to the national societies here represented, briefly as follows:

(*a*) It is the sense of this convention that it is highly desirable to hold in San Francisco, in the month of September 1915, an International Engineering Congress.

(b) It is the sense of this convention that the general plan of organization and management herein outlined is that which will prove best adapted to this purpose, and such plan is therefore recommended to your favorable consideration.

(*c*) Should such outline meet with your approval, this convention begs to recommend prompt action on the appointment of the proposed local executive committee as herein suggested, and early consideration of ways and means to provide for the clerical help and other expenses necessary to make its work effective.

Ethics for Electrical Engineers

The following code of principles of professional conduct of the American Institute of Electrical Engineers was adopted by the Board of Directors, March 8, 1912. While the principles express, generally, the engineer's relations to client, employer, the public, and the engineering fraternity, it is not presumed that they define all of the engineer's duties and obligations.

A. General Principles

1. In all of his relations the engineer should be guided by the highest principles of honor.

2. It is the duty of the engineer to satisfy himself to the best of his ability that the enterprises with which he becomes identified are of legitimate caracter. If after becom-

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ing associated with an enterprise he finds it to be of questionable character, he should sever his connection with it as soon as practicable.

B. The Engineer's Relations to Client or Employer

3. The engineer should consider the protection of a client's or employer's interests his first professional obligation, and therefore should avoid every act contrary to this duty. If any other considerations, such as professional obligations or restrictions, interfere with his meeting the legitimate expectation of a client or employer, the engineer should inform him of the situation.

4. An engineer cannot honorably accept compensation, financial or otherwise, from more than one interested party, without the consent of all parties. The engineer, whether consulting, designing, installing, or operating, must not accept commissions, directly or indirectly, from parties dealing with his client or employer.

5. An engineer called upon to decide on the use of inventions, apparatus, or anything in which he has a financial interest, should make his status in the matter clearly understood before engagement.

6. An engineer in independent practice may be employed by more than one party, when the interests of the several parties do not conflict; and it should be understood that he is not expected to devote his entire time to the work of one, but is free to carry out other engagements. A consulting engineer permanently retained by a party, should notify others of this affiliation before entering into relations with them, if, in his opinion, the interests might conflict.

7. An engineer should consider it his duty to make every effort to remedy dangerous defects in apparatus or structures or dangerous conditions of operation, and should bring these to the attention of his client or employer.

C. Ownership of Engineering Records and Data

8. It is desirable that an engineer undertaking for others work in connection with which he may make improvements, inventions, plans, designs, or other records, should enter into an agreement regarding their ownership.

9. If an engineer uses information which is not common knowledge or public property, but which he obtains from a client or employer, the results in the form of plans, designs, or other records, should not be regarded as his property, but the property of his client or employer.

10. If an engineer uses only his own knowledge, or information which by prior publication, or otherwise, is public property, and obtains no engineering data from a client or employer, except performance specifications or routine information, then in the absence of an agreement to the contrary, the results in the form of inventions, plans, designs, or other records, should be regarded as the property of the engineer, and the client or employer should be entitled to their use only in the case for which the engineer was retained.

11. All work and results accomplished by the engineer in the form of inventions, plans, designs, or other records, that are outside of the field of engineering for which a client or employer has retained him, should be regarded as the engineer's property unless there is an agreement to the contrary.

12. When an engineer or manufacturer builds apparatus from designs supplied to him by a customer, the designs remain the property of the customer and should not be duplicated by the engineer or manufacturer for others without express permission. When the engineer or manufacturer and a customer jointly work out designs and plans, or develop inventions, a clear understanding should be reached before the beginning of the work regarding the respective rights of ownership in any inventions, designs, or matters of similar character, that may result.

13. Any engineering data or information which an engineer obtains from his client or employer, or which he creates as a result of such information, must be considered confidential by the engineer; and while he is justified in using such data or information in his own practice as forming part of his professional experience, its publication without express permission is to be considered improper.

14. Designs, data, records, and notes made by an employee and referring exclusively to his employer's work, should be regarded as his employer's property.

15. A customer, in buying apparatus, does not acquire any right in its design but only the use of the apparatus purchased. A client

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does not acquire any right to the plans made by a consulting engineer except for the specific case for which they were made.

D. The Engineer's Relations to the Public

16. The engineer should endeavor to assist the public to a fair and correct general understanding of engineering matters, to extend the general knowledge of engineering, and to discourage the appearance of untrue, unfair, or exaggerated statements on engineering subjects in the press or elsewhere, especially if these statements may lead to, or are made for the purpose of, inducing the public to participate in unworthy enterprises.

17. Technical discussions and criticisms of engineering subjects should not be conducted in the public press, but before engineering societies, or in the technical press.

18. It is desirable that first publication concerning inventions or other engineering advances should not be made through the public press, but before engineering societies or through technical publications.

19. It is unprofessional to give an opinion on a subject without being fully informed as to all the facts relating thereto and as to the purposes for which the information is asked. The opinion should contain a full statement of the conditions under which it applies.

E. The Engineer's Relations to the Engineering Fraternity

20. The engineer should take an interest in and assist his fellow-engineers by exchange of general information and experience, by instruction and similar aid, through the engineering societies or by other means. He should endeavor to protect all reputable engineers from misrepresentation.

21. The engineer should take care that credit for engineering work is attributed to those who, so far as his knowledge of the matter goes, are the real authors of such work.

22. An engineer in responsible charge of work should not permit nontechnical persons to overrule his engineering judgments on purely engineering grounds.

Size of Ocean Vessels

Loss of the *Titanic* lends special interest to the discussion that will take place before the International Congress of Navigation at Philadelphia, May 23, on the probable dimensions of the sea-going vessels of the future. Six papers, treating various technical phases of the subject, especially in relation to the dimensions to be given to maritime canals, have been submitted by G. de Thierry, professor an der Königl. Technischen Hochschule Charlottenburg, Mitglied der Internationalen Technischen Commission des Suez Kanals, Berlin-Halensee, Germany; H. Vander Vin, Ingénieur en chef Directeur des Ponts et Chaussées, Antwerp, Belgium; E. L. Corthell, civil engineer, New York; J. Foster King, chief surveyor to the British Corporation for the Registry of Shipping, Glasgow, Great Britain; C. Leemans, civil engineer, Amsterdam, Holland; E. I. Zamjatin, naval engineer, St. Petersburg, Russia. In preparation for the Congress these have been reviewed and summarized by C. E. Grunsky, civil engineer, of San Francisco, and who says that if it be admitted that the dimensions of the sea-going vessels are to be determined solely by the needs of trade and commerce, by economy of operation, and by the demands of passengers for speed, comfort, and luxuries, without regard to harbor facilities and without regard to the possible usefulness of the vessels to their governments in case of war, then it becomes comparatively easy to predict future growth. The law would really be inexorable, and no one could foresee a limit to the size of the largest vessel. But there are other considerations to be taken into account, notably the general usefulness of large vessels, which, according to their size and particularly their draught, may be materially restricted by the dimensions of maritime canals and the depth of the approaches to the principal harbors of the world. To this point particular attention is asked, and the Twelfth International Navigation Congress may well consider whether or not it is desirable to point out other means of restricting the rate of increase in the size of vessels than only by the demands of the ship-owners and the ability of the shipbuilders to comply with these demands.

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It appears from all of the papers which have been submitted that there is no check yet apparent to the rate at which the dimensions of the largest sea-going vessels are increasing. The vessel of over 50,000 tons is being built, and those who should know, expect the vessel of 70,000 tons or more to put in her appearance soon. Some of the transatlantic steamship companies are so heavily subsidized that their ships are practically in government ownership. On the Pacific, too, the economic success of transportation in large vessels is made possible by subsidies in one form or another. Our own country, which does not subsidize, is out of the running. It has no merchant marine to speak of. In other words, the operation of large steamers without subsidy is not profitable; at any rate, not in competition with subsidized vessels. And yet, if commerce between nations had been developed without government aid, and if the commerce on the high seas had been and were carried on only by vessels of moderate size, there would have been a suitable adjustment to such conditions and there would be little if any less volume of business between nations than is found today. Perhaps, upon careful analysis, it may, even under established conditions, be found preferable to operate ten steamers of 10,000 tons each rather than only two of 50,000 tons. From the standpoint of the government of any maritime country it would certainly be more desirable to have at its disposal when needed ten ships of 10,000 tons than two of 50,000 tons.

G. de Thierry, after making the statement that the largest ocean vessels are always those on the routes between Europe and North American ports, refers to the fact that there is an ever-increasing size of vessels on other routes. He calls attention to the falling off in the number of vessels of smaller tonnage. Among the conclusions which Mr. de Thierry formulates there may be particularly noted his first, according to which only the dimensions of vessels ruling at the time of the canal construction should be taken into account; and his fifth, that the depth of water under the vessel of greatest draught should be 1 metre (3.28 ft.); and finally his sixth, that the area of the canal section should be at least five times that of the largest vessel. The first seems predicated upon purely financial reasons, and, if literally construed, would in most cases be too severe a restriction. The conclusions with reference to depth of water under the keel and the area of the canal section come with full force from an engineer of experience.

H. Vander Vin, referring to the dimensions of larger vessels, believes that, especially draught and length considered from the point of view of stability, the maximum point on the curve of increase may have been reached. Figures are quoted in order to show that among the harbors that have an entrance depth of less than 9 metres there are many of importance. Unless they can be improved to greater depth at reasonable cost, the vessels entering them will be limited in maximum size by the harbor depth. It follows from this that the growth of commerce on new routes of travel, the increasing commerce of Europe and America with South America and with the Orient, with China, with Japan, and Australia which, with the completion of the Panama canal may be expected to grow more rapidly than that between New York and Europe, will have a retarding effect upon the rate at which the size of the large ocean vessels as a class is increasing. At the same time, it may reasonably be assumed that it will be without effect upon the rate of increase in the size of the largest vessels which are found only upon the route between Europe and New York.

Mr. Corthell contends "that the size of merchant ships is determined by the inexorable laws of commerce, trade, economy of transportation, and the demands of passengers for room and comfort." He quotes experts to substantiate his contention that the building of large ships is economical and that the size of merchant ships is determined by the inexorable laws of commerce. Speaking of the fact that increase in the draught of steamers 500 ft. (152.4 metres) long and upward falls short of the normal increase, he says that this is evidently due to the shallow depth of the Suez canal and to the lack of depth in the approaches to the port of Buenos Aires and other harbors of restricted depth. He assumes that maritime canals of the larger class should be large enough to allow the passage of the larger class of commercial steamships in two directions simultaneously.

The largest vessel is the least likely to

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suffer from the destructive powers of the sea, says Foster King, and this fact coupled with economy of operation leads the shipowners on to the construction of the largest vessels justified by their interpretation of trade conditions. But the tendency to exceed certain limits of size is opposed by the dimensions of existing dry-docks and by the depth of water at the entrance to ports. Mr. King finds that apart from the 'abnormal' steamers of *Lusitania*, *Mauretania*, *Olympic*, *Titanic*, *Emperator*, and *Aquitania* type, the increase of breadth of beam has been at the rate of 8 ft. (2.44 metres)in 10 years, and that this rate applies as far back as 1864. The abnormal vessels, however, indicate a rate in recent years of 21 ft. (6.14 metres) in 10 years. The draught in 60 years for passenger steamers other than those classed as 'abnormal' has, he says, increased 50% (practically one-third of the draught of today). The same increase in draught is noted for cargo steamers. The half dozen large vessels of abnormal dimensions seem to have a mean draught of about 36½ ft. (11.1 metres). Referring to the largest passenger vessels on other routes, he says that it is apparent that some influence is holding back the rate at which their dimensions might otherwise be expected to increase. He intimates that the depth of navigable water in the important harbors of the world and the dimensions of the Suez canal have been potent restraining factors, but he believes that the depth of water in the Panama canal—adequate for vessels with a draught of 40 ft. (12.2 metres)—and satisfactory traffic conditions on the Suez canal will stimulate the rate at which the depth of the latter will be increased, and that these canal facilities will react upon dimensions of ships and therefore also upon the harbors of the world.

C. Leemans dwells upon the fact that the enlargement, and particularly the deepening of maritime canals, has at once been followed by their being used by larger vessels, and he recommends two sets of dimensions for the maritime canals and canal locks, of which the first is for steamers serving the lines to New York, to Boston, and to Canadian ports, and the second for steamers of other ocean routes. Without dwelling upon the fact that the motor-boat, by reason of economy in weight and space of machinery and fuel, will increase the efficiency of the vessels of whatever size in which used, and will thereby be in some measure a restraining influence upon the rate of their growth, he expresses his confidence in the petrol motor and its adaptability for use on sea-going vessels of large size. Mr. Leemans points out that the financial results of operating the large vessels are not always satisfactory. Government aid in the form of subsidies or otherwise is necessary. No reliable returns are available to demonstrate the unsatisfactory results of operating the largest type of vessels, but it seems probable that without government aid in the past, there would have been a much less rapid rate of increase in dimensions. Mr. Leemans believes that special consideration should be given to the vessels built with large freight capacity and for moderate speed, 16 to 19 knots. Within another 15 years he thinks we may see on the Atlantic vessels of a gross tonnage of 70,000 to 75,000, with a draught of 12.5 metres (41 ft.), and he ventures to prophesy the economic and technical possibility of vessels 1500 ft. (458 metres) long and 160 ft. (48.8 metres) beam, having a draught of 14.5 to 15 metres (47.6 to 49.2 feet).

E. I. Zamjatin refers to the increasing size of vessels as demonstrated by the size of those visiting Russian ports as well as by reference to vessels in general. The conclusion is reached that the maximum rate of growth has been passed. The man of small capital must necessarily content himself with vessels of a more modest type than *Lusitanias* and *Mauretanias*, and his activity holds down the average size that might otherwise be expected. The suggestion is also made that the risk of inadequate business increases with the size of the vessels. The purpose of the increasing size of vessels is to reduce freight rates. The reduction in the cost of transportation decreases with the size of the ship because the freight capacity in its relation to dead weight increases with the gross tonnage, and because the operating expenses decrease with the increasing size. The conclusion is emphasized that the relative decrease of power and the corresponding decrease of fuel required is the chief source of profit to the owner resulting from the increase of size. Mr. Zamjatin draws particular attention to the value of the internal-combustion engine

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in comparison with steam-engines for the propulsion of large vessels. He believes that the steam-engine will be displaced. The utilized caloric energy of the internal-combustion engine is given at 37% as compared with 17% for the steam-engine. Boilers and stokers are eliminated. The mileage of the vessel equipped with an internal-combustion engine is given at four to six times the mileage of a vessel propelled by steam. The weight of the fuel required will be one-fourth to one-sixth of the former when compared with the latter. The weight of the machinery will be only one-half. The cost of fuel, too, will be only about one-half. Based on an equal percentage of profit, he concludes that at 12.5 knots a Diesel-motor boat of 14,000 tons may compete successfully with a steam boat of 21,000 tons; and at 18 knots a Diesel-motor boat of 14,000 tons may compete with a steam boat of 36,500 tons.

Having given consideration to the views of the experts as presented in the foregoing papers, Mr. Grunsky adds that if the deepening of the harbors and of harbor approaches is continued without restriction, the size of the largest ocean liners will, under otherwise permanent conditions, continue to increase. They will be built constantly larger as demanded by economy of operation and by the needs of commerce, and only those ports can hope to be favored with the visits of the largest vessels which find it worth while to afford suitable harbor facilities. The growth of vessels exerts a strong influence upon the concentration of the export and import business at certain points. It is to the interest of the port which is less favored by natural conditions that some artificial limit be set to the size of the ocean carriers, particularly in the matter of draught, in order that harbor improvements may be planned with reasonable certainty that they will be adequate. There should be an international agreement and there should be no government aid to vessels whose dimensions are such as to make the entrance into a harbor of standard depth impossible. It would be unwise for the United States to construct or to encourage by subvention or otherwise the construction of vessels too large to pass through the locks of the Panama canal. By the construction of the canal the United States has practically set an upper limit for the dimensions of vessels whose construction can be encouraged by the Government. The canal and the lock system on the canal have cost too much to be readily modified. The usable lock length on this canal is 1000 ft., the breadth of 110 ft. and the depth of 41.5 ft. on the sills of the lock gates, equal to 40 ft. in salt water, or 12.2 metres. Standard maximum dimensions for the largest desirable sea-going vessels will not set a limit for the further improvement of shipping. There is room for improvement even when the limit of size has been reacned. The internal-combustion engine, for example, is full of promise, and in the matter of speed there need be no limit set, unless for subsidized vessels it be a lower limit. The largest vessels on such special routes as the one between New York and European ports stand apart in a class by themselves, and their dimensions need not be taken into account in forecasting the dimensions of the vessels for whose use the great maritime canals are constructed.

The following conclusions appear to be justified and are recommended for adoption by the Congress.

1. It is desirable that a limit be set to the draught of sea-going vessels.

2. Government aid should not be extended to the building or operation of sea-going vessels whose draught exceeds 9.5 metres (32.2 feet).

3. There should be an international agreement fixing the maximum dimensions of sea-going vessels built or operated under government subvention, and there are tentatively suggested the following: Length over all, 900 ft. (275 metres); breadth, 105 ft. (32 metres); draught, 32.2 ft. (9.5 metres).

4. Any maritime canal which has locks with a usable length of 1000 ft. (305 metres), a width of 110 ft. (33.6 metres), and a depth of water on the sill of 35 ft. (10.7 metres) will fulfill every reasonable requirement of commerce.

5. In a maritime canal a wet section five times as large as the immersed portion of the largest ship which is to use the canal, is desirable, as also a depth of one metre under the keel; but these values are functions of the speed at which the canal is to be navigated and therefore to some extent also of the volume of commerce, and are to be determined by local conditions.

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Proposed Board of River Regulation

IN the opinion of Francis G. Newlands, United States Senator from Nevada, the time has come for abandonment by the Government of its long-continued piece-meal policy of development of inland waterways. He has recently introduced Senate bill No. 122, in which is proposed a Board of River Regulation of large powers and responsibility. A comprehensive plan for systematic regulation of the rivers, with construction of reservoirs, levees, and other public works that incidentally shall serve for irrigation, drainage, and other useful purposes, is outlined. All details are to be left to the board itself, the function of Congress being held to be to furnish the authority and funds. It is felt that the wise policy of leaving details to the engineers in charge should be followed here, as it has been in the case of the Reclamation Service and the Panama canal. It is provided that $50,000,000 per year be appropriated and set aside as a special fund in the Treasury, to be known as the 'River Regulation Fund,' to be used for the regulation of interstate commerce and in aid thereof for examinations and surveys and for the construction of engineering and other works and projects for the regulation and control of the flow of navigable rivers and their tributaries and source streams, and for the standardization of such flow, and for flood prevention and protection, by the establishment, construction, and maintenance of natural and artificial reservoirs for water storage and control, and by the protection of watersheds from denudation and erosion and from forest fires, and by the maintenance and extension of woodland and other protective cover thereon, and by the reclamation of swamp and overflow lands, and by the building of drainage and irrigation works, and by doing all things necessary to provide for any and all beneficial uses of water that will contribute to its conservation or storage in the ground or in surface reservoirs as an aid to the regulation or control of the flow of rivers, and by acquiring, holding, using, and transferring lands and any other property that may be needed for the aforesaid purposes, and by doing such other things as may be specified in the act or necessary to the accomplishment of the purposes thereof, and by securing the coöperation therein of states, municipalities, and other local agencies, and for the payment of all expenditures provided for in the act; the purpose being river regulation and the control of the volume of water forming the stage of the river from its sources, so as to standardize the river flow, as contradistinguished from and supplemental to channel improvement as heretofore undertaken and provided for under the various acts commonly known as the river and harbor acts.

A board is to be created, to be known as the 'Board of River Regulation,' consisting of the Chief of Engineers of the United States Army, the Director of the U. S. Geological Survey, the Forester of the Department of Agriculture, the Director of the Reclamation Service, the Chief of the Bureau of Plant Industry of the Department of Agriculture, the Secretary of the Smithsonian Institution, one civil engineer, one sanitary engineer, and one hydro-electric engineer. The last three are to be appointed by the President and to hold office at his pleasure, and they are each to receive an annual compensation of $7500. The members of the board, with the exception of the three appointed by the President, are to serve as such only during their incumbency in their respective and official positions, and any vacancy on the board is to be filled in the same manner as the original appointment. The work of this board is defined as follows: "That the board shall develop, formulate, prepare, consider, and determine upon comprehensive plans for the conservation, use, and development of the water and forest resources of the United States in such manner as will best regulate the flow of source streams and navigable rivers, and embracing, with that object, flood protection, drainage, and the reclamation of swamp and overflow lands; water storage in natural and artificial reservoirs; the beneficial use of waters for irrigation and for all domestic, municipal, and industrial purposes; the maintenance and development of underground water supplies and the storage of waters in the ground and in irrigated lands and underground reservoirs; the enlargement of the areas and raising of the levels of the ground waters; the construction of flood-water canals, by-passes, and restraining dams; the control and regulation of

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drainage and the replenishment of streams by return seepage; the perpetuation of forests and maintenance of woodland cover as sources of stream flow; the prevention of denudation and erosion; the protection of river channels from eroded soil materials; the clarification of streams; the utilization of water-power; the prevention of the pollution of streams and rivers; the sanitary disposal of sewage and purification of water-supplies; the best distribution of forests, woodlands, and other growth, and of cultivated and irrigated areas in their relation to river flow; the protection of forested and woodland areas from destruction by fire or insects; the reforestation of denuded areas; the planting of forests and establishment of forest plantations; the preservation and planting of woodlands and any other growth and protective cover on watersheds; the increase and development of the porosity and absorbent qualities and storage capacity of the soil upon which rain or snow may fall; the making and furnishing of plans for flood-water storage and other works for irrigation and power for farms, towns, and villages; the acquisition, subdivision, and settlement in small, intensively cultivated farms of lands for water storage by irrigation; the building of the irrigation systems for such lands, including reservoirs, dams, canals, ditches, and all necessary works; the protection of farms, villages, towns, and municipalities from damage by freshets and overflow; and the impounding of flood waters in artificial lakes and storage reservoirs to prevent floods and overflows, erosion of river banks, and breaks in levees, and to regulate the flow of streams and reënforce such flow during drought and low-water periods, the ultimate object of all such work being to regulate and, so far as possible, standardize the flow of navigable rivers and source streams, and in the accomplishment of that object to induce and secure coöperation of states, municipalities, districts, counties, towns, and other local agencies and organizations." Provision is made for allotment of funds between the various bureaus so that each shall be prepared to execute the particular duties assigned to it in the general plan.

International Definition of Weston Cell

THE Weston normal cell value has been the subject of an investigation by a technical committee whose conclusions, as reported to the International Technical Committee at Washington, D. C., are as follows:

1. The committee decides to choose as the value of the Weston normal cell the mean value of the cells presented by the delegates of the four laboratories. This was obtained by first determining the mean value of the normal cells presented by each delegate, then a mean was taken of the four members thus found.

2. The committee decides to choose, as the value of the international ohm, to be recommended to all countries for general use, the mean of the values of the units realized at the Physikalisch-Technische Reichsanstalt and at the National Physical Laboratory, for the present and until there are other mercury ohms prepared. Although the international ohm as defined by the London Conference has not yet been strictly realized, the committee believes that its value has been attained in two laboratories independently with a good degree of precision, and that future work is not likely to change it by more than 2 or 3 parts in 100,000.

3. In view of the fact that the mean of the results with the silver volt-meter obtained by this committee will probably not be changed by more than a few parts in 100,000 when the specifications are finally completed, the committee decides to recommend to the International Committee on Electrical Units and Standards the following value for the electromotive force of the Weston normal cell:

$E = 1.0183$ international volts at 20°C.

On the subject of the standard cells, the committee is of the opinion that new experiments are necessary before completing or changing the specifications of the London Conference.

On the subject of the ohm, the committee expresses the hope that new international ohms, fulfilling the specifications of the London Conference, may be realized soon in different laboratories. The silver volt-meter question requires further experimentation.

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Engineers' Note Book

As a means of doing away with the air-compressor for Diesel engines, A. Nougier in *Le Génie Civil*, recommends preheating the air drawn into the engine, basing his claim on the principle that a slight increase in the temperature of the air at the beginning of the compression stroke results in a large increase of temperature at the end. The following equations for the adiabatic compression of air, together with the curves plotted, accordingly illustrate graphically the results that would be obtained by preheating.

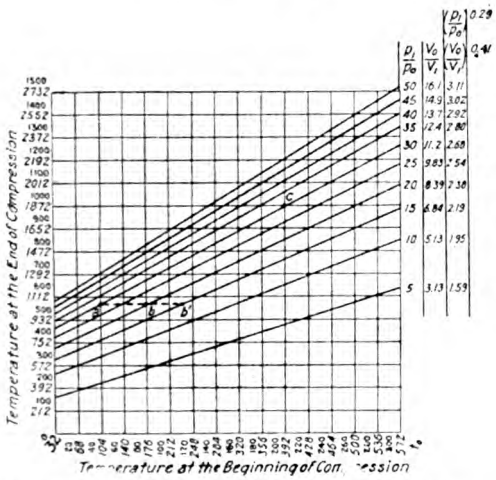
$$(1) \quad \frac{p_1 v_1}{T_1} = \frac{p_2 v_2}{T_2}$$

$$(2) \quad p_1 v_1^{1.41} = p_2 v_2^{1.41}$$

$$(3) \quad p_1^{0.71} v_1 = p_2^{0.71} v_2$$

By dividing, member by member, (1) by (2), the relation

$$(4) \quad T_1 = T_2 \left(\frac{v_2}{v_1}\right)^{0.41}$$



ADIABATIC COMPRESSION—RISE OF TEMPERATURE CURVES FOR AIR

The small, vertical figures indicate deg. cent.; the larger, inclined figures, deg fahr.

is obtained, which gives the final absolute temperature T_1 of air taken at initial absolute temperature T_2 and subjected to adiabatic reduction of volume $\frac{v_2}{v_1}$.

By dividing, member by member, (1) by (3), the relation

$$(5) \quad T_1 = T_2 \left(\frac{p_1}{p_2}\right)^{0.29}$$

is obtained which gives the final absolute temperature T_1 of air taken at initial absolute temperature T_2 and subjected to adiabatic compression $\frac{p_1}{p_2}$. The figure gives a set of curves expressing the relations (4) and (5) for certain values of $\frac{v_2}{v_1}$ and $\frac{p_1}{p_2}$. For each given value of $\frac{v_2}{v_1}$ or $\frac{p_1}{p_2}$, equations (4) and (5) represent straight lines, and all these straight lines meet at a point having the coordinates —273 and —273°C. The third row of figures on the upper right corner indicates the values of $\left(\frac{p_1}{p_2}\right)^{0.29}$ or $\left(\frac{v_2}{v_1}\right)^{0.41}$ which would be equal to the angular coefficient of the line if the scale of the abscissæ were equal to that of the ordinates. This graph facilitates the obtaining of the final temperature t when the initial temperature, t_1, and adiabatic compression is known and can be expressed either in the form of $\frac{p_1}{p_2}$ or as $\frac{v_2}{v_1}$.

RELATIVE values of wood, coal, and oil may be conveniently stated as below:

	Kern River Oil, bbl.
Wood (1 cord)—	
Oak	2.50
Average pine	2.00
Heavy fat pine	2.25 to 2.50
Dry redwood	2.00
Average redwood	1.75
Coal (1 ton)—	
Welsh anthracite	5.00
Australian bull's eye	4.00
Australian Sydney	4.00
Wellington	3.50
South Prairie	3.50
Franklin	3.50
White ash	3.50
Wellington screenings	3.00
Roslyn	3.00
Coos Bay	2.50 to 3.00
Seattle	2.00 to 2.50
Tesla	1.75 to 2.25

A MIL is a unit of length used in measuring the diameters of wires, and is equal to 0.001 inch. A circular mil is a unit of area used in measuring the cross-sections of wires, and is equal to $\frac{0.7854}{10^6}$ square inch.

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Book Reviews

BUILDING STONES AND CLAYS. By Edwin C. Eckel. Pp. 264; ill., index. John Wiley & Sons, New York, 1912. For sale by the *Mining and Scientific Press*, San Francisco, California. Price $3.

This forms a companion volume to Mr. Eckel's well known 'Cements, Limes, and Plasters,' though it differs slightly in scope. The origin, character, and methods of examination of building stones form the subject of the main chapters which constitute part I of the new volume. The five that comprise the second part include discussion of the classification of clays, the characteristics of residual clays, of transported clays, the distribution of clays, and the field examination of clay deposits. In form of treatment the two parts of the volume are similar. In part I the individual chapters deal with the origin and structure of rocks, igneous rocks in general, granite and other acid igneous rocks, trap rock and other basic igneous rocks, serpentine and soapstone, sedimentary rocks in general, slates, sandstones, limestones, marbles, field examination and valuation of stone properties, and the laboratory testing of stone. The book is authoritative, well written, and well illustrated. It stands in sharp contrast to most building stone reports in that there is no attempt to describe individual quarries and small space is devoted to the distribution of the various building stones. The general geological introduction is clear, though slight. It is striking that in so modern a book, written by so excellent a geologist, the nebular hypothesis is accepted as a basis, though it is true that for the purpose of the writer any simple form of statement was satisfactory. We are glad to see a sharp discrimination between the use by the engineer of geologic data and his possession of a geological point of view. The difference is more important than is commonly considered. Mr. Eckel has had the advantage of service both as a geologist and engineer and has also a thorough grasp on the literature of his field. The result is a book of double usefulness and, incidentally, one that is very readable. The chapter on slate is much the most interesting, and the one on field examination of stone properties the freshest and, possibly, most helpful. His statement as to the engineer's responsibility for flotations might well be committed to memory by every engineering graduate. As he says: "By this time the public has become accustomed to seeing admirals, clergymen, generals, and senators appear as sponsors for oil companies, mining promotions, and all sorts of swindles—and it looks on this in the charitable conviction that of course they can know nothing about the business and are simply foolish. With an engineer, however, the case is different, and the view taken is usually far from charitable."

It is to be wished that Mr. Eckel had not condensed quite so much his chapters on the different stones and had given more relating to their occurrence in its relation to quarry methods and the commercial phases of the stone industry. On the other hand, his treatment of the chemical composition of building stones is unusually full, and his bibliographies are excellent. Altogether, the book is one that can be highly recommended.

TRANSACTIONS OF THE COMMONWEALTH CLUB OF CALIFORNIA, March 1912.

The transactions of this unique Club are issued in the form of separate bulletins, each reporting a separate meeting. That for March was devoted to the 'Control of San Francisco Harbor.' The meeting was addressed by J. H. Rosseter, C. T. Wright, I. N. Hibberd, and J. J. Dwyer. A valuable collection of figures relating to San Francisco harbor are here brought together and made public. It is interesting to record that this harbor is owned and controlled by the state and that all improvements have been made out of harbor dues. Mr. Dwyer discussed some of the engineering difficulties involved in harbor work at this point and stated that the San Francisco waterfront has 26 wharves, many of them built with much difficulty in soft mud, reaching 800 ft. out into the bay. The foundation is better south of the Ferry building than north. Contrast $14,000,000 so far spent on the San Francisco waterfront with $16,000,000 spent by Liverpool lately to construct a basin merely for four large ships. Everything here is paid by ships, cargoes, or by rents. Of 26 wharves, 17 have concrete piles, and 9 are of wood. Of the 17 concrete docks, 5 are good; the other 12 vary from fair to bad. The poor condition is due largely to lack of

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money in the past, partly to incompetent engineering, and partly to bad inspection. To these is due such failures as the Lombard-street wharf, built four years ago at a cost of $171,000. The Harbor Board has necessarily adopted the policy of maintaining old wharves as long as possible in order not to disturb commerce. It has now arranged for eight new piers, two 800 ft. long, three 200 ft. wide; also for four new ferry slips and two 450-ft. extensions of the Ferry building. Harbor charges at San Francisco are moderate in comparison with other places, but a more equitable system may be devised. The waterfront in the past has suffered from politics, but it is the purpose of the present administration to have it taken out of politics and kept out. Commerce is increasing. Last year, despite the bad condition of river navigation, over $60,000,000 worth of products were brought to San Francisco by way of the Sacramento and San Joaquin rivers. Before the completion of the Tehauntepec railroad four or five years ago, ocean-to-ocean commerce by sea was only $5,000,000 or $6,000,000. Last year, by Tehauntepec and Panama, it was over $100,000,000. When the canal opens this will be multiplied by twenty again.

Handbook of Steam-Shovel Work. The Bucyrus Co., South Milwaukee, Wisconsin. Pp. 370, index. For sale by the *Mining and Scientific Press*, San Francisco, California. Price $1.50.

This book is a compilation of data gathered by the construction department of the Bucyrus Co., and is intended primarily for the use of contractors in making calculations and estimates on such work as may require the use of steam-shovels. The subject of cost is given careful attention and the series of formulæ accompanied by typical cost-curves and data upon which to base estimates will be decidedly helpful. The book is divided into ten chapters, dealing with the nature of the problem, general conditions and formulæ, field conditions, estimating, shovel-work in sand and gravel, earth and glacial drift clay, iron ore and rock, the last chapter being devoted to directions for moving, economic hints, etc.

The subject matter contained in the chapters on handling material consists of data giving actual results accomplished in specific cases, rather than a discussion of theory, such formulæ as are given being simple in character and easy of application. This method of treatment enhances the value of of the book, as it is within the comprehension of any contractor, whether he be technically educated or not, and places at the disposal of both estimator and operator the experience resulting from encountering many diversified conditions. In the publication of this book, the Bucyrus Co. has performed a genuine service and the fact that it is interested in the sale of the apparatus used in no way detracts from the value of the subject matter.

Rock Drilling. By R. T. Dana and W. L. Saunders. Pp. 319; ill., index. John Wiley & Sons, New York, 1911. For sale by the *Mining and Scientific Press*. Price $4.

Following a general introductory statement covering blasting and explosives, this volume treats in detail the methods and costs of open-cut excavation and submarine rock-drilling. It is based principally on material collected and compiled by engineers of the Construction Service Co., and includes accurate records of cost and drill duty in many kinds of work. Diagrams and tables are freely used in such shape as to make more than a mere record of cost. Accurate comparisons and analyses become easy. The book is well written and well illustrated and is sure to prove of large value to consulting and constructing engineers.

U. S. Geological Survey Publications.

Water-Supply Paper 280. Gaging Stations Maintained by the United States Geological Survey, 1888-1910, and Survey Publications Relating to Water Resources. Compiled by B. D. Wood. 1912. 102 pages.

Surface Water Supply of the United States, 1910. Prepared under the direction of M. O. Leighton. Part II, Water-Supply Paper 282. South Atlantic Coast and Eastern Gulf of Mexico, by M. R. Hall and J. G. Mathers. 1912. 109 pages, 3 plates.

Topographic Maps. — Cambridge, Ohio; Creede, Colorado; Cut Bank, Montana; Delhi, New York; Gilbert, West Virginia-Virginia-Kentucky; Honcut, California; Milledgeville, Georgia; Ontario Beach, New York; Ray, Arizona; Rolla, Missouri; Tisdale Weir, California; Yellowstone Park, Wyoming-Montana-Idaho, new edition.

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Engineering Bonds

*Tax exempt in California.
†Legal investment for savings banks in California.
‡Available as security for deposit of state, county, and municipal funds and postal savings deposits.

*The California Gas & Electric Corporation has issued unifying and refunding mortgage 5% gold bonds dated November 1, 1907, due November 1, 1937, in denominations of $1000. This company is a part of the Pacific Gas & Electric system, the bonds being secured by direct mortgage lien on all the property formerly belonging to the California Gas & Electric Corporation now owned in fee by the Pacific Gas & Electric Co. The earnings of the Pacific Gas & Electric system in 1911 were gross $14,604,609.30; operating expenses, etc., $8,214,071.97; net earnings $6,390,537.33; interest on bonds paid $3,254,133.27; balance $3,136,404.06. The property covered by these bonds extends throughout 24 counties in central California, including the San Francisco Bay section and portions of the Sacramento and San Joaquin valleys, including the cities of Oakland, Berkeley, Alameda, Sacramento, Stockton, San Jose, and embracing an area of approximately 33,000 square miles; 161 communities are served with electric light and power, 40 with gas for heating and lighting; 8 with water for domestic purposes; and 1 (Sacramento) with a street railway system.

†The Northern California Power Company Consolidated has issued refunding and consolidating mortgage 5% sinking fund 40-year gold bonds, dated December 1, 1908, due December 1, 1948, in denominations of $1000. These bonds are a direct first mortgage on approximately 80% of the total generating capacity of the system and a refunding mortgage on the plants of the property. The company has in operation four electric generating plants having a total capacity of 27,000 hp. The fifth plant will have an installed capacity of 20,000 hp. There are 392 miles of high tension transmission lines; 29 sub-stations of an installed capacity of 23,743 kw. Gas is manufactured and distributed in Redding, Red Bluff, and Willows, and water is distributed in Redding and Willows. In addition to various established water rights, the company owns and holds more than 20,000 acres of valuable land. The bonded debt of the company is less than $100 per horse-power, without taking into consideration the gas and water supply plants owned. The gross earnings for 1910 were $594,580.22; operating and general expenses $193,350.63; net earnings $401,229.59; interest on bonds $136,645.61; leaving a balance of $264,583.92.

*†Natomas Consolidated of California authorized an issue of $15,000,000 first mortgage 6% gold bonds, January 1, 1910, due January 1, 1930. These are coupon bonds in denominations of $500 and $1000. For the month of May 1911 the gross earnings were $219,570.84; operating expenses $72,561.72; net earnings $147,009.12; interest on first mortgage 6's and underlying bonds $61,555; balance available for interest on second mortgage bonds and betterments $85,454.12. This company is made up of a consolidation of the Natoma Land & Mining Co., the Folsom Development Co., the Feather River Development Co., the Folsom Rock Co., and the Natoma Development Co. Their property includes approximately 90,000 acres of land with improvements thereon, 60,000 acres of this being reclamation lands adjoining and lying north of the city of Sacramento; 30,000 acres of irrigated lands near Folsom, together with an irrigation system, and 7000 acres tested and proved gold-bearing gravel dredging land located at Natoma near Folsom and on the Feather river near Oroville. The rock-crushing department has a total capacity of 4500 tons per day. Engineering reports as to the physical valuation and earning capacity were made by Charles M. Rolker, Stephen E. Kieffer, George L. Dillman, and others.

City of Oakland has issued $450,000 of 4½% gold bonds dated January 1, 1910, and due January 1, 1915-50. These bonds are in denominations of $1000, the funds to be expended for municipal improvements. The assessed valuation in 1911 was $123,223,700; the total bonded indebtedness $4,907,350; population in 1910 was 150,174.

*‡The city of Tracey, California, has issued sewer bonds dated August 1, 1911, and due August 1, 1928-41, inclusive, in denominations of $500, with interest at 5%. The total assessed valuation in 1910-11 was $496,000. The total debt, including this issue, is $50,000; total population 1350.

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Company Reports

Spring Valley Water Company

The report of W. B. Bourn as president of the Spring Valley Water Company for the year ended December 1, 1911, was presented to the stockholders at the annual meeting held in San Francisco on April 10, 1912. The total number of water connections on January 1, 1912, was 58,858, a gain for the year of 1988. Reference is made to a decision rendered by the Circuit Court in Iowa as strengthening the position of the company as regards pending legal proceedings on the subject of rates, the substance of this decision being that a water company was entitled to earn dividends equal to 8% on the value of its plant in view of the hazards of the business and the current rates of interest in the state. Mr. Bourn states that the policy of the company as set forth in the report for 1908 recommending complete publicity in all affairs pertaining to water supply and accounts and a continued effort to lay a foundation for determining a just and equitable price for an immediate sale will be consistently adhered to. The property is being valued for the company by J. G. White & Company.

The balance sheet and the statement of the profit and loss account follows:

ASSETS

Capital assets:		
Real estate, water rights, rights of way, and other properties, as at Jan. 1, 1911	$46,286,765.19	
Additions during the year	2,354,104.89	
	$48,640,870.08	
Less deductions	174,389.95	
		$48,466,480.13
General mortgage 4% gold bonds:		
In treasury (including 782 bonds pledged)	$1,281,000.00	
Capital expenditures prior to Dec. 31, 1911	1,847,000.00	
		3,128,000.00
Bills and accounts receivable		$51,847.82
Materials, supplies, and equipment		323,881.63
Consumers' accounts		74,574.68
Cash on hand and in banks		130,643.83
Mercantile Trust Co. of San Francisco 15% deposit under injunction, and accrued interest		951,501.65
		$53,126,929.74

LIABILITIES

Capital stock		$28,000,000.00
Stock assessment	$840,000.00	
Deduct replacement	611,336.31	
		228,663.69
General mortgage 4% gold bonds (including 3128 bonds as shown above)		20,987,000.00
Current liabilities		1,819,040.74
Depreciation and obsolescence		961,199.25
Contingent and insurance fund		550,000.00
Surplus net revenue:		
Balance Jan. 1, 1911	$426,215.98	
Net revenue 1911	714,810.08	
	$1,141,026.06	
Less dividends 18, 19, 20, 21	560,000.00	
		581,026.06
		$53,126,929.74

PROFIT AND LOSS ACCOUNT, 1911

Operating expenses	$664,959.55
Interest:	
On bonds	714,360.00
Miscellaneous	6,978.79
Taxes	392,227.91
Depreciation and obsolescence	260,000.00
Contingent and insurance fund	240,000.00
Surplus net revenue	714,810.08
	$2,993,336.33
Water sales	2,891,337.38
Rents	74,806.63
Discount	171.64
Suburban company	14,058.80
Sundry sales	5,051.19
Service connections	4,387.50
Turn ons	566.00
Lake Merced silica mine	2,957.19
	$2,993,336.33

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Engineering News

Irrigation and Water Supply

San Francisco.—The Spring Valley Water Co., at its annual stockholders' meeting, elected the following officers and directors: F. B. Anderson, T. B. Berry, W. B. Bourn, A. Borel, S. P. Eastman, E. L. Eyre, C. Osgood Hooker, I. W. Hellman, Jr., Homer S. King, E. J. McCutchen, Louis F. Monteagle, A. H. Payson, and J. M. Quay. The report of the company is reviewed elsewhere. An examination of the properties was recently made by John R. Freeman on behalf of the city, and a valuation by J. G. White & Co. for the company is soon to be compiled.

Sacramento.—The Delta Irrigation & Land Co. has applied to the Railroad Commission for permission to issue bonds on its property in Fresno county for the purchase of the J. G. James Co., a corporation owning water plant and water rights at the Fish Slough ranch in Fresno county. The price is said to be set at $2,500,000.

Stockton.—At a meeting of the Stockton Rivers Regulation Committee, the members voted to pledge themselves to raise $10,000, to be used as a campaign fund to promote the passage of the Newlands bill providing for the establishment of national reservoirs. The construction of a canal from Paradise dam to a point near Antioch, to relieve congestion in the San Joaquin river, has been proposed.

Modesto.—The directors of the Modesto Irrigation District have levied an assessment amounting to $20,300 for making necessary improvements. The Utah Construction Co. has completed three of the tunnels for the Oakdale Irrigation District and approximately $6000 worth of work per day is being done.

Watsonville.—The Watsonville Water Co. will build a pumping plant and reservoir to have a capacity of 3,000,000 gallons daily for municipal water-supply.

Washington, D. C.—The Board of Army Engineers has ordered a complete investigation of the irrigation and navigation possibilities of the San Joaquin river above Stockton.——The Reclamation Service announces that construction work at the Pathfinder dam has been completed and water is being stored for the coming season.

Ely, Nevada.—J. H. Smith of Oakland, and A. B. Colwell, County Commissioner of White Pine county, Nevada, are said to be developing an irrigation project to serve 30,000 acres in Lincoln county, Nevada.

Billings, Montana.—The Big Horn Canyon Irrigation & Power Co. is preparing to develop an irrigation project to reclaim the body of land lying on both sides of the Big Horn river between the canyon and Custer. A dam will be built across Big Horn canyon to be 175 ft. high, creating a reservoir that will have a capacity sufficient for irrigating 125,000 acres of land and generating 8000 electrical horse-power. It is proposed to build an electric transmission-line from Custer through the Big Horn valley.

Johnston, Colorado.—A municipal water-supply system is to be completed by the city to include a 15,000,000-gallon reservoir, filter system, and gravity water pipe-lines.

Power, Gas, and Electricity

San Francisco.—At the annual meeting of the stockholders of the Great Western Power Co., held in San Francisco, the following directors were elected to serve for the ensuing year: A. C. Bedford, A. W. Burchard, Walter S. Crandall, H. P. Wilson, R. B. Young, of New York; A. W. Bullard, Guy C. Earl, Herbert Fleishhacker, Mortimer Fleishhacker, of San Francisco; James Irvine, Santa Ana, Cal.; H. H. Sinclair, Los Angeles, Cal. The officers of the company are: Mortimer Fleishhacker, president; A. W. Bullard, vice-president; Herbert Fleishhacker, vice-president; H. P. Wilson, vice-president and secretary; Guy C. Earl, vice-president; H. H. Sinclair, vice-president; F. M. Tompkins, treasurer and assistant secretary; W. H. Spaulding, assistant secretary; C. E. Mynard, assistant treasurer and auditor.——The Sierra & San Francisco Power Co. has petitioned the State Railway Commission to grant its application for a franchise to construct a power-line from Alviso, in Santa Clara county, to Salinas in Monterey county.——The annual meeting of the Pacific Gas & Electric Co. was held in San Francisco on April 9 and elected the following board of directors: Frank B. Anderson, Henry E. Bothin, John A. Britton, W. H. Crocker, E. J. de Sabla, Jr., F. G. Drum, John S. Drum, D. H. Foote, A. F. Hockenbeamer, C. O. G. Miller, William G. Henshaw, John Martin, Samuel Insull, Louis Sloss, and George K. Weeks. The following officers were reëlected: President, F. G. Drum; first vice-president

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and general manager, John A. Britton; second vice-president and treasurer, A. F. Hockenbeamer; secretary and assistant treasurer, D. H. Foote; assistant treasurer, Joseph C. Love; assistant secretaries, Charles L. Barrett of San Francisco and Morris K. Parker of New York. The following is the income account statement for 1911 as presented:

Gross revenue		$14,604,609.30
Expenditures for maintenance, operation, taxes, and reserve for uncollectable accounts, casualties, etc.		8,214,071.97
Net revenue		$6,390,537.33
Bond interest		3,254,133.27
Balance		$3,136,404.06
Preferred stock dividends	$600,000.00	
Sinking fund payments	773,226.54	
Amortization of bond discount and expense	75,671.84	
		1,448,898.38
Balance		$1,687,505.68

Hydro-electric power-plants aggregating 101,000 hp. are being planned, including the construction of a reservoir of 30,000,000,000 gallons.——The Central California Power Co. has petitioned the Railroad Commission to grant its application for a stock and bond issue of $40,000 with which to purchase the properties of the Home Gas Co. in Porterville and its franchises in Exeter and Tulare county.

Oakland.—C. Gillespie, appraisal engineer for the J. G. White Co. of New York, has filed a report on the holdings of the Pacific Gas & Electric Co. in Oakland. The valuation of the plant is given in the summary as $7,195,434. The total value of real estate is $1,033,730, of which $395,282 is charged to the electrical department and $636,448 to the gas department. The generating capital for the Oakland gas plant is stated as $1,029,488, and the transmission capital for the same plant as $78,194, a total of $1,107,682. The total distribution capital is given as $2,147,109.

Vallejo.—Two bond elections were authorized by the City Council amounting to $175,000, including $100,000 for the establishment of a municipal light and power plant. The Supervisors have granted a franchise to the Great Western Power Co. to operate in Solano county.

Lakeport.—The Yolo Water & Power Co. has commenced development work on an irrigation project to serve approximately 200,000 acres in Yolo county. It is stated that electricity will also be generated for power and lighting purposes. Clear Lake is the source of water-supply and covers 80 square miles.

Oroville.—The Feather River Power & Irrigation Co., affiliated with the W. P. Hammon interests, has been incorporated with a capital stock of $10,000,000. The directors are A. N. Lewis, Jr., H. J. Hill, A. L. Dahl, S. O. Van Dernse. It is stated that a power-plant will be built in the Feather River canyon.——The U. S. Geological Survey, represented by J. T. Haviland, has commenced a complete survey of the middle fork of Feather river from Bidwell.

Porterville.—At a stockholders' meeting of the Home Gas Co., on April 6, the following officers were elected: Charles S. S. Forney, of Los Angeles, president; E. E. Graham, vice-president; H. B. Landis, of Los Angeles, secretary; E. J. Broberg, of Porterville, treasurer, and J. H. Stradee, of Los Angeles, director. It is stated that the distribution system is to be reconstructed and that a gas main 14 miles long will be laid from Porterville to Lindsay.

Fresno.—The San Joaquin Light & Power Co. is about to commence a survey for the power-line to be constructed across the mountains from Coalinga to the coast. A. G. Wishon is general manager.

Portland, Oregon.—The Northwestern Electric Co., capital stock $20,000,000, has filed an application for a 25-year franchise for the construction, maintenance, and operation of a light, power, and heating system in the city of Portland. The Fleishhacker interests, Wm. H. Crocker, and Antoine Borel of San Francisco, are said to be interested, and power-sites are to be developed on the Klickitat, Lewis, and White Salmon rivers.——The Camas Pulp & Paper Co. of Camas, Washington, is preparing to enlarge its plant on the Salmon river for the purpose of developing 3000 additional electrical horse-power for use in its paper mills.

El Paso, Texas.—The El Paso Gas & Electric Co. will build a gas-holder to cost about $35,000. T. J. Jones is general manager.

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Railways

San Francisco.—The contract for constructing the roadbed of the municipal railway on Geary street was awarded to Bates, Borland & Ayer, their bid being $225,025. The contractors, however, claimed to have made an error in the figures submitted and have repudiated their bid. The city re-advertised for bids and the contract was awarded to P. H. Mahoney, of Mahoney Bros.——The Secretary of the Interior has asked the House of Representatives to authorize the Federal Government to use construction equipment and supplies on the Panama canal released at the completion of the work, for building a government railroad in Alaska from tidewater at Resurrection bay, to the Yukon valley.——The Guggenheim interests have offered to sell the Copper River & Northwestern railroad in Alaska to the U. S. Government. This railroad runs from Cordova 197 miles, terminating at the Bonanza copper mine. A sale of this railroad would render it unnecessary for the Government to build a railroad of its own.——It is stated that the Southern Pacific company has in course of preparation plans for the conversion of the San Francisco peninsula suburban lines from steam to electricity.——A franchise for a street railway system in Redwood City has been granted Edward F. Fitzpatrick. The first line to be constructed will be from the business centre of Redwood City to the foothills of Woodside and Portola districts.——The Monorail Rapid Transit Co. has been incorporated at San Francisco; capital stock $10,000,000; directors, A. J. Wright, Kellogg Van Winkle, Otto E. Jonnson, Fred G. Cox, and Thomas E. Haven. An experimental oval of track is to be built and negotiations have been opened toward the installation of this type of railway at the Panama-Pacific Exposition.——It is stated that the United Railroads of San Francisco is to build a terminal building on the corner of Market and Valencia streets, which will be similar to that of the Pacific-Electric company in Los Angeles.——The Mill Valley & Mt. Tamalpais railroad will build an elevator car system for service between the tavern and the Muir woods, a distance of approximately 400 feet. ——A portion of the $25,000,000 adjustment mortgage bonds voted upon April 27 by the stockholders of the Denver & Rio Grande railroad will be used for acquiring $2,500,000 of the obligations of the Western Pacific. Part of this money is to be used by the Western Pacific company for the completion of the Sacramento shops and the acquisition of a new ferry steamer.——The Western Pacific is said to have closed a contract for three years with the Central California Traction Co., operating between Sacramento and Stockton, through Lodi, for an exchange of traffic whereby the railroad will handle exclusively all of the interstate traffic furnished by the Traction company.——The United Railroads in a report recently completed, showed gross earnings for 1911 aggregating $7,886,136, as compared with $7,653,489. The net earnings for 1911 were $3,583,165, as compared with $3,372,318.

Oakland.—The Oakland & Antioch Electric railroad has secured a right of way through the MacDonald property in the vicinity of 59th street and College avenue, and has also secured 7 acres of the adjoining Butters tract and 6½ acres of the Reyes tract.

Tulare.—Preliminary survey of the right of way for the Big Four Electric railway between Tulare, Visalia, Porterville, and Woodville has begun. C. C. Holleron is the engineer in charge. David Oliver Jr. and H. M. Coffin of San Francisco are said to be financially interested in this project.

Portland.—The Mt. Hood Railway & Power Co. is said to have been purchased by the Portland Railway Light & Power Co. C. M. Clark, of the banking house of E. W. Clark & Bro. of Philadelphia, is reported to have effected a purchase at a price of $5,000,000. The Mt. Hood property includes 20 miles of steam railroad track and hydro-electric plant. It is stated that the steam road will be electrified at an early date.

Panama-Pacific Exposition

Excellent progress has been made during April toward the completion of general plans for the Exposition. A block plan showing the preliminary general arrangement of buildings to be placed on that portion of the site that lies between Fort Mason and the Presidio has been prepared and is to be exhibited at a mass meeting to be held at Dreamland rink, in the early part of May. Permanent landscape gardening work has already commenced. Trees are being removed and boxed, preparatory to planting within the Exposition grounds. One

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of the largest nurseries in the world is to be established within the Presidio grounds. This nursery will cover 32 acres. Plans and specifications are ready for bidders for greenhouses, lath houses, and water supply for nursery. Plans and specifications will also soon be submitted to bidders for a portion of the Presidio sewer system, and later for the entire sewer and water supply system for the Exposition.

On April 14 the San Francisco Bridge Co. started the work of filling approximately 71 acres of water lots at Harbor View. A suction dredge is being used for this work, which will have to handle a total of more than 1,000,000 yd. of sand. Action has been taken by the Board of Directors, establishing February 20, 1915, as the opening date and December 4, 1915, as the closing date for the Exposition, the entire time covering a period of 41 weeks.

Engineering Construction

San Francisco.—The Board of Supervisors has passed a resolution asking the Board of Public Works to furnish preliminary plans and surveys for the Filmore street tunnel. Estimates of costs have been made by Bion J. Arnold.——The Board of Fire Commissioners have asked for an appropriation exceeding $1,000,000, to be used for replacing the horse-driven apparatus now in use with motor-driven apparatus.——C. E. Grunsky has reported to the Board of Public Works the following estimate of cost for the Stockton street tunnel project: approaches and appurtenances, $434,667; appropriated for preliminary engineering studies, $200; due for appraisement of benefits and damages, $3500; estimated cost of printing, $200; appraised damages to property within the boundaries of assessment districts, $138,907; appraised damages to property not within assessment districts, $37,254. Total, $616,528. ——The State Harbor Board has awarded a contract for 125,000 basalt paving bricks to Wymore Brothers, at $59.50 per thousand. ——A contract has been awarded for widening pier No. 12, at the foot of Folsom street, to the Thompson Bridge Co., for $2100.30.—— A contract for removing rock underlying the proposed pier at the foot of Harrison street has been let to O'Brien Brothers & Smith Co., for $9900.70.

Oakland.—The City Council is considering ordinances appropriating $32,900 for the construction of fire houses and to extend to the salt-water high-pressure auxiliary fire system and new sewer and culvert work. Further sums of $18,000 for additional houses, $13,500 for extension of the salt-water system, and $1400 for culvert and sewer work are under consideration.——Resolutions have been adopted addressed to the U. S. War Department asking that permission be granted to the Oakland, Antioch & Eastern railway to erect a bridge to be used jointly for railroad and public highway purposes, from Black Diamond and Chipps Island across the San Joaquin river.——The county surveyor is making surveys and taking soundings off the foot of Madison street for the construction of the proposed subway between Oakland and Alameda.

Port Costa.—Construction work is to commence immediately on the new ferry slip for the Southern Pacific.

Martinez.—Construction work started April 17 on the main pipe-line to connect this city with the plant of the Contra Costa Gas Co., of Pittsburg. Pipe-lines will also be laid for supplying the towns of Antioch, Pittsburg, Bay Point, and Martinez.

Lafayette.—The tunnel through the Berkeley hills, now under construction for the Oakland & Antioch Electric railway will in all probability not be completed before December 1, instead of July 1 as was expected.

Crockett.—It has been announced that the Port Costa Lumber Co. has sold water front property to the Southern Pacific company and that a freight terminal is to be constructed for the Oriental trade.

Stockton.—The City Council has authorized the mayor to expend $6000 for the purchase of 14 acres upon which to build a city incinerator, pumping plant, and septic tanks.

Niles.—Mr. Haviland, county surveyor, has prepared plans for a concrete bridge to cost approximately $75,000 to be erected across Alameda creek at Niles. There will be five spans of 100 ft. each, the piers for each span to be sunk to bedrock. Plans will be ready for bidders about May 1.

Fresno.—Bids were received on April 11 for the construction of the 28.6-ft. span monolite bridge on Bullard avenue as follows: Easterly Construction Co., $2487; Worswick Street Paving Co., $2450; J. E. Mitchell, $2380.

Meridian.—It has been announced that bonds worth $1,000,000 have been authorized

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by the Alameda Sugar Co., for the purpose of building a sugar factory at this city.

Ft. Bragg.—A bond election recently held for the purpose of voting bonds for the improvement of street has failed of ratification by the voters. The trustees will carry out the improvements by assessing property-owners, and work is expected to be under way shortly.

Sisson.—A $40,000 6% bond issue was ratified by the voters on April 2. Of this amount $20,000 is to be expended for the purchase of a municipal water works and the balance for a sewer system and city hall.

Selma.—Bids are wanted for dredging; material to be removed is approximately 250,000 to 300,000 cu. yd. For particulars address W. H. Schafer, Selma, California, or W. W. Ward, Kingsbury, California.

Seattle.—An estimate furnished by H. M. Chittenden places the total amount of public fund pledged for harbor improvements at $13,500,000; and the amount of funds, public and private, in prospect at $6,500,000, making a total of $20,000,000 available within the next five years.

Washington, D. C.—Through the efforts of California Congressmen, items have been attached to the legislative appropriation bill for a complete survey of Crescent City harbor and vicinity and for an appropriation of $15,000 for dredging the inner harbor of Humboldt bay.

Washington, D. C.—The total excavation at Panama last month was 2,803,013 cu. yd., against 2,643,410 in February. There were two more working days in March and 0.86% less rainfall. Concrete totaling 128,375 cu. yd. was laid in March, an increase of 14,911 cu. yd. over the February total. The amount of fill placed in the dams was 582,755 in March and 418,248 in February.

Petroleum

San Francisco.—The total gross production of the California oilfields for March was 7,275,004 bbl. of crude petroleum. There was consumed in the field 443,089 bbl., leaving the net production 6,923,908 bbl. The total storage on hand at the end of the month was 43,005,609 bbl., as against 42,060,297 at the end of the preceding month, an increase of 945,312 bbl. The daily average of production for March was a little less than that of February. Details follow:

	March. Bbl.	February. Bbl.
Coalinga	1,692,524	1,492,910
Kern River	934,484	909,483
McKittrick	484,351	475,093
Maricopa	434,150	413,180
Midway	1,933,369	1,865,237
Lost Hills	78,934	69,111
Totals	5,557,812	5,225,014
COAST		
Santa Maria-Lompoc Cat Canyon	418,923	434,343
Summerland	4,350	4,350
Totals	423,273	483,693
SOUTHERN		
Fullerton	471,775	446,520
Salt Lake	227,362	203,955
Whittier	64,552	59,080
Coyote	90,742	85,216
Los Angeles City	31,842	31,842
Ventura County	45,632	42,741
Newhall	10,918	9,621
Totals	942,823	878,975
Grand totals	6,923,908	6,532,682

STOCKS, MARCH 1

	Field.	Pipe-line.	Total.
Totals	3,644,867	39,360,742	43,005,609

Efforts to develop petroleum fields in New Zealand are meeting some success. At New Plymouth five wells have been drilled, of which three yield 36, 40, and 70 bbl. respectively. The wells are 2280 to 2320 ft. deep.

Coalinga.—The California Natural Gas Co. has been granted rights of way for its pipe-line. The Valley Oil Co. has brought in well No. 1 on section 32-20-15, near the town of Coalinga. The well is flowing at the rate of 250 bbl. per day. The casing is down 3275 ft. The oil is 17.4 Beaumé.——The Caribou Co. has brought in its well on section 28-31-23, depth 3440 ft. A company of Eastern capitalists is proceeding to develop oil on the Reeden ranch in the Carrizo district.

Bakersfield.—The General Pipe Line Co. is reported to have offered a $5000 cash bonus to the city of Los Angeles for a franchise and has agreed to pay the city 2% of the gross receipts, based on a trunk line mileage of 170 miles, without counting the laterals, with a guaranteed minimum of $200 per month for one pipe-line and $400 for two. A

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franchise has been granted to Barneson and Fitzpatrick for a right of way along the San Pedro water front in order that the Pipe Line company may have access to water shipping facilities. The Associated Oil Co. has let a contract for the construction of a 750,000-bbl. reinforced concrete oil reservoir at Avon, which will be the site of the new oil refinery. The General Pipe Lines Co. has voted to increase its bonded indebtedness to $25,000,000. Articles of incorporation of the Pacific Pipe Line Co. have been filed with the clerk of Kern county. The company purposes to build a pipe-line from Maricopa in Kern county to Ventura on the Pacific ocean. The incorporators are: E. Fletcher Scott, Floyd Warrin, Milton Dyer, D. K. Gault, A. A. Kidder, Jr., Harry Price, M. S. Pattison, Leonore Turman, and Ira W. Byrnes. ——A new gusher was brought in by the Standard Oil Co. on section 36-31-23 near Bakersfield, April 25. The flow was estimated at 8000 bbl. and continued four hours before the well sanded.

EASTERN PRODUCTION

Statistics of production and development in the Eastern and Middle Western oilfields of the United States are regularly collected by the *Oil City Derrick*. The following is a summary of the figures for the month of March:

Field Report.—Reports from the Eastern, Mid-Continent, and Texas and Louisiana fields show that 921 wells were completed, giving a total new production of 44,902 bbl. This is an increase of 80 in the number of wells completed, and of 1377 bbl. in new production. The increase comes from Texas and Louisiana and the Blue Creek field of West Virginia, with slight additions in the old regions of Pennsylvania and Lima. The Mid-Continent fields, Illinois and southeastern Ohio, showed a considerable decline in the new production. There were a total of 165 failures and 78 gas wells among the completions. New work under way on the last day of March aggregated 503 rigs and 1088 drilling wells, a total of 1591. These figures show an increase of 53 in the number of rigs and of 132 drilling wells as compared with the report of the previous month. Each of the great divisions show an increase in new work with the exception of Texas and Louisiana, where there was a decrease. The Mid-Continent field has the largest increase, the additional new work totaling 144 more than in February.

Pipe-line Report.—The receipts of oil from the wells by the pipe-lines of Pennsylvania, Lima, and Kentucky fields which make regular monthly reports, aggregated 2,399,796.27 bbl. in March, an average of 77,412 bbl. per day. This was an increase of 462,823 bbl. over the receipts for February, and an increase of 10,620 bbl. in the daily average. The average daily receipts for the same month a year ago were 80,663 bbl., and the runs for March 1912 were greater than those of any month since June 1911.

The receipts from the wells in Illinois amounted to 2,068,102 bbl., a daily average for March of 66,713 bbl. This was an increase of 99,334 bbl. in the total receipts, but a decrease in the daily average as compared with the figures for the short month of February. The decrease from the report a year ago amounted to over 500,000 barrels.

The runs of the Prairie Oil & Gas Co., from the Mid-Continent field in March, were 2,369,495 bbl., a daily average of 76,435. This was an increase of 59,097 in the total, but a decrease of over 3200 bbl. per day as compared with the report for February, when the average runs were 79,668 and 78,433 bbl. in January.

The total receipts in March of the lines making reports in all the divisions represented were 6,837,393 bbl., a daily average of 220,561 bbl. In February the same lines showed runs amounting to 6,216,137 bbl., and a daily average of 214,384 bbl., the increase in the total for March amounting to 621,256 barrels.

Stocks.—The following table shows the amount of the various grades of oil held by the several pipe-lines in the different divisions of the oilfields at the close of business March 31, 1912:

Grade of Oil.	Total barrels.
Pennsylvania	3,965,689.06
Lima	3,010,540.30
Kentucky	238,629.35
Illinois (Eastern lines)	2,058,101.45
Illinois (Ohio Oil Co.)	17,278,537.27
Kansas (Eastern lines)	3,218,209.94
Kansas (Prairie Oil & Gas Co.)	40,377,119.28
Total March 31	70,146,826.65
Total February 29	71,481,583.56
Decrease	1,334,756.91

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Markets

MATERIALS FOR CONSTRUCTION

(San Francisco prices, April 30.)

Shapes—Angles, tees, and channels, 3 in. and under, $2.35 per 100 lb.; over 3 in., $2.25 per 100 lb.; I-beam, 4 in. to 15 in., $2.35 per 100 lb.

Bar Steel—Rounds and squares, $2.25 base per 100 lb.

Wire Nails—$2.55 base per 100 lb.

Black Sheet Steel—No. 18-20, $3.35; No. 22-24, $3.40; No. 26, $3.45; No. 27, $3.50; No. 28, $3.55; No. 30, $3.75.

Steel Plates—No. 16, $2.90; No. 14, $2.75; No. 12, $2.70; No. 8, $2.70; No. 10, $2.55; 3/16, $2.35; ¼ in. and heavier, $2.25; all per 100 lb.

Rails—Steel T, 8-lb., $2.15; 12-lb., $2.05; 16-lb., 20-lb., and 30-lb., $2.

Pig Iron—No. 1 Scotch, $25.00 to $27.50.

Coke—German Syndicate, forked foundry, $16 to $17.50 per long ton; average to arrive ex-ship, $15 per long ton.

Portland Cement—In sacks, $2.35 per bbl.

Lime—$1.25 per bbl.

Fire-Brick—Imported Carr, Cowen, or Snowball, $50 per 1000; domestic Livermore, $38 per 1000.

Fire-Clay—$10 per ton.

OIL SHARES

(By courtesy of San Francisco Stock Exchange, April 29.)

	Bid.	Ask.		Bid.	Ask.
Assd Oil..	..	$17.00	Palmer ...	.60	.61
Brookshire.	$0.60	.65	do Union	..	.30
Caribou ..	1.20	..	Premier ..	.50	.60
Clarem't ..	.60	..	Republic .	.35	.40
Coal Cent.	..	.10	Rice R'nch	1.20	..
Cresceus...	..	.03	Sacramento	..	1.00
De Luxe...	.75	..	S'r Dough.	1.10	..
Dominion .	..	.75	Sec. 25....	22.50	..
Empire ..	1.15	..	Silver Tip.	.90	..
Junction ..	..	.27	Sovereign .	..	.14
Maricopa	36 ..	.70	S W & B..	.20	.25
Mascot ...	..	.90	Sunset Mon	..	1.10
Mecca	..	1.25	Turner ...	..	.95
McKittk ..	.09	..	Union ...	100.00	100.50
Mid Premr	..	.55	United Oil.	..	.29
Mte Cristo.	1.37	1.40	Wolverine.	.80	.90
Mex Pet..	73.00	..	W K Oil..	..	2.20
New Pa Pet	.49	..	West Un..	..	.97

CALIFORNIA OIL DIVIDENDS FOR MARCH

Company.	Rate.	Amount.
Amalgamated	$2.00	$150,000.00
*Brick	0.04	127,254.16
Caribou	0.025	8,070.30
Central	0.015	15,400.00
Claremont	0.015	7,500.00
Columbia	0.01	9,992.26
Fullerton	0.05	30,000.00
Home	0.10	7,500.00
Homestake	0.01	1,000.00
Monte Cristo	0.025	12,500.00
*Mount Diablo	0.015	7,500.00
New Pennsylvania	0.005	2,500.00
Paraffine	0.01	3,000.00
Record	0.01	10,000.00
Rice Ranch	0.015	4,500.00
San Francisco-McKittrick	0.10	5,000.00
Sauer Dough	0.02	7,500.00
Section 25	0.25	10,000.00
Silver Tip	0.05	15,000.00
*State Consolidated	0.01	5,000.00
Traders	0.006	9,000.00
Union	0.006	183,387.50
Union Provident	0.006	90,767.60
United Petroleum	0.006	48,450.60
Western Union	0.01	10,000.00
W. K.	0.03	15,000.00
Total California		$745,842.42
Mex. Pet., Ltd., pfd.....	0.002-3	80,000.00
Grand total		$825,842.42

*Unlisted.

SAN FRANCISCO QUOTATIONS.

(San Francisco Stock & Bond Exchange April 29.)

LISTED.

	Bid.	Ask.		Bid.	Ask.
Assd Oil 5.102	103¼		OakW g 5.	94½	..
Bay C P 5.101½	..		OmCa R 6.102	..	
CC G&E 5.102½	..		Oro Elec 5.	97¾	98
CE ser A 5 85	..		PacGasI 4.	89¼	..
C G & E 5.102½	103		PacG&E 5.	92⅛	92½
do Un5..	96⅜	..	Pac E R 5.106		..
Cal-stCa 5.102	..		PacL&P 5.	97	..
Cen CTrc 5	95½	..	do gtd 5.	99½	100
City Elec 5	90	91	PacT&T 5.100	⅜	..
C C Wat 5. ..		98	P & C H 6. ..		100½
do gm 5. ..		96	P & O R 6.100		..
T E L A 5.102		..	Peo Wat 5.	75	75⅛
E L & P 6..105		..	S EG&R 5.103		104
F & C H 6.100¼		..	SD&Cuy 5.	97½	..
Gt W Pr 5. ..		85½	S J L&P 5.	99	..
HR T&L 6.105½		..	S F T R 5. ..		90
Lk Tahoe 5 ..		96	SFN&CR 6.101½		..
L BchGs 6.100		..	SFO&SJ 5.105¼		..
Ls An E 5.100¼		..	do 2 m 5. ..		97½
L A G&E 5 ..		101	do Con 5.	93¼	..
do Corp 5 ..		98½	SJ&SC 4½. ..		88
Ls An R 5.107		..	S B G&F 6.100		..
do Corp 5	95	97	S R of C 6 ..		102
L A Lt g 5.100		..	S P 1c g 5.112½		..
L A-P 1c 5.105		..	SP Br C 6.126½		..
L A-P C 5. ..		101	SP 1st ref 4	95⅛	95½
MarW&P 5.	90	100	U G & E 5..101		101¼
Mkt-stCa 6.100	⅝	..	Val C P 5..101		..
do 1c m 5 ..		92½	Water Stocks—		
MV&MT 5.100		..	Marin Co..	53½	..
Nat Con 6..	93¾	..	Peo W pfd.	50	52
N R of C 5.112½		..	Spring Val	63¾	64⅛
N Cal R 5..105½		..	Gas & Elec Stocks—		
N Cal Pr 5.100¼		101	N Cal PrCn ..		..
do Con 5 ..		94½	Oro El pfd.	75½	76
N Elec 5..	92⅜	..	do com..	18¼	19
O G L&H 5 ..		102¼	Oro Water.100		..
OakTran 6.105		..	Pac Lt pfd.	73½	..
do 5 ....105½		107½	do com..	79½	..
do Con5.102		..	St R R Stocks—		
Oak Trc c 5	97¾	98⅜	California 125		..
do 5	90	90¾	SF-OTA pfd 85		..

UNLISTED.

	Bid.	Ask.		Bid.	Ask.
Am Riv E5	97½	..	Oak C R.. ..		20
Bay C P 5.103½		104	Oak Trc pfd	83	..
BlueLW 6.102½		..	do com..	30	40
Ben WC 5. ..		103	Oak R R 6.100½		..
C C G&E 5.	92	..	Oak & ARy	19¾	..
CalE gen 5.	87¼	..	do 5..... ..		80
do pfd...	70	..	Oro Dev...	45	..
C & N W 5.104		104¾	OW L&P 6 ..		105
C O L & P. ..		90	Pac P Cem	70	77½
C G Pr bds.	92¾	93	Pac H & S. ..		20
do 5.....	91	91¾	do 5..... ..		92½
E S W 5.. ..		100	Pac S Sec. ..		¾
Ewa E S..	34	..	Pac S Co.. ..		135
EsperanOil6 ..		85	Pac G & E.	92½	93
GasCon As. ..		29	do com..	66½	67
Gt W pfd..	61¼	..	do 5.....104½		..
do com..	32	35½	do rites.60c		..
Gen Petrol. ..		20	Peo W com	3¼	3½
HuntL&I 6.100		103	P & C Ry.	12¼	..
Kern L Co.180		..	Pet & S RR	92	..
Keswick c 6 ..		102½	do stock.	20	..
Key R pfd.	83	..	Poul Wrls.	25¾	30
do com.. ..		25	SF & SJV 5 ..		111½
LtL&P bds	65½	..	SF & NP 5.104¼		105
do com.. ..		89½	S P C R 5..	92½	95½
L&P G C 6. ..		98	Std Prt Cem	20	23
do dev 5.	90	..	do bonds.	91¼	92
L & A Ry.	99	104¾	S F Secur. ..		43
Mut Elec 5.	97	..	SF G&Coke ..		15
M W P&E.101½		..	SF G & E 5	93	..
N B D O M.300		350	do n c 4½	98	..
Noble Elec. ..		25	S J Water.105		..
Nat Con...	13½	16	SJ Ter R 5 ..		75
do 2.....	71¼	..	Sis L&P 6.	90	..
N P C R 5.	99¾	100¼	S Yuba 5..107		109
NatD Co 6.100		..	StandEl c 5	92	93¼
Nat I C S..	50	..	Sun Tel 5..104		..
NatL&M 6.100		..	Sut-st R 6. ..		98
N W Elec.	14	..	West Pac...	11	..
Ocn Shore 5 ..		12	do 5.....	87¾	88
O C nw stk	9½	13	WPC&Enfd	22½	..
Ocn S S 5.100		..	Yos Val R. ..		89

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Industrial Progress

Westinghouse Direct-Current Turbo-Generators

Westinghouse type T, direct-current turbo-generator units find wide application where a simple, compact, reliable generating set is desired. Many are used for exciter sets in alternating-current generating stations, for lighting and power in industrial plants and in office and apartment buildings, for storage-battery charging in railway signal work, and for train lighting. They are particularly applicable for exciter service in modern generating stations where the steam pressure exceeds 125 lb. per square inch, because small reciprocating engines ordinarily used for driving exciters are usually designed for pressures not greater than 125 lb. per square inch. Where the boiler pressure exceeds 125 lb. per square inch, a reducing valve must be used with such engines. Type T turbines operate directly on pressures up to 200 lb. and with steam superheated. As compared with reciprocating engine sets, the features in favor of the Westinghouse turbo-generator set are: Simplicity and reliability, there being few moving parts such as rods, levers, eccentrics, and cranks, few parts that require attention because of wear, very few bearings to oil, and no stuffing-boxes to pack, and no reciprocating parts to wear out, and no steam cylinders to be oiled; compactness, a reciprocating engine set occupying from one-half to several times as much space (depending on the speed and other characteristics) as does a turbo-generator set; lower cost of installation, the first cost and the installation cost being less for a turbo set than for an equivalent reciprocating engine set, and expensive foundations not being required for a turbo-generator unit; there is no oil in the exhaust steam.

The line of type-T sets includes machines of the capacities most in demand, namely, from 10 kw. to 200 kw. Standard voltages are 125 and 250. Three-wire generators—125 and 250 volts—can be supplied. The steam-pressure range is from 75 to 200 lb. per square inch. Either shunt or compound wound generators can be furnished. Standard compounding is 118 volts no load, and 125 volts full load, or 235 no load and 250 full load. Compounding can be varied by adjusting the shunt. The turbine is of the single-wheel impulse type. The wheel or rotor is mounted directly on the end of the generator shaft. Although only one impulse-wheel is used, an unusually high efficiency is obtained by using the steam two or more times on the one wheel. The governor is of the fly-ball type. The weights are hung on hardened steel knife-edges, minimizing friction. In case of overspeeding, the automatic safety-stop throttle valve is tripped, shutting off the steam supply. Type T generators are of the commutating type, which insures sparkless commutation with a fixed brush position at all loads within the capacities of the machines. Frames are of cast iron. Bolts hold the pole pieces to the frames. All frames are divided horizontally. Main poles are built up of soft sheet-steel punchings. The use of bolted-on poles permits of uniform pole spacing, and in addition renders possible the removal of any individual pole. Commutating poles are of steel and are secured to the frame with bolts. Main field coils may be either shunt or compound wound. Shunt coils are wound on forms and provide a large radiating surface. Series coils are wound of bare copper bar. The best possible heat radiation is assured. The commutating pole coils are wound of bare copper bar held in position with insulated bolts. The ventilation is thorough. Brush-holders are mounted on rigid arms, and the brush tension can readily be adjusted to keep it uniform, as the brush wears away. Armatures are of the drum type. Armature coils are form wound, interchangeable, and thoroughly insulated. The spaces between the coils at the ends of the armatures are packed with insulating material to prevent the entrance of dirt. Commutators consist of hard-drawn copper bars insulated with mica. Steel rings shrunk around the bars, but insulated therefrom, prevent distortion from centrifugal stresses.

A complete oiling system of the type best adapted to the service is provided with each turbine. In the smaller sizes the well-known ring oiling scheme is employed. In the larger turbines the oil is circulated through a closed system, by means of a rotary pump driven by the main shaft through positive gearing. All parts of the turbine are readily accessible for inspection or repair. The

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upper half of the cylinder or casing may be removed without interfering with the valve or governor mechanism, and, if necessary, the wheel or rotor may be entirely removed from the casing. Generally speaking, the steam consumption of turbines of small powers compares favorably with the performance of automatic high-speed engines of similar capacity. As Westinghouse turbines are carefully tested in the shop before shipment, there can be no uncertainty as to their performance. The guarantees of steam consumption are based on an average of actual test results plus a comfortable margin.

Personal

F. W. Locke has been appointed assistant superintendent of streets at Richmond, California.

Otto von Geldern has been re-elected president of the Pacific Association of Scientific Societies.

Adolph Ohman and W. Hickman, of Eureka, have been appointed harbor commissioners at that port.

Edward O'Connor has been appointed mechanical engineer to the Board of Architecture, San Francisco.

Charles M. Schwab is in San Francisco conferring with the Union Iron Works officials regarding construction of an additional dry dock at Hunters Point, large enough for the deepest draught vessels.

The University of California student branch of the American Society of Civil Engineers has elected the following officers: J. B. Brown, president; W. H. Jaenicks, vice-president; E. D. Nickerson, treasurer; E. H. Rhodes, secretary; Gordon Zander, librarian; and H. J. Sams, sergeant at arms.

William R. Eckart, Jr., has been advanced from assistant professor to professor in the mechanical engineering department at Stanford University. Charles N. Cross has been appointed assistant professor of the same department, and John H. Foss assistant professor of civil engineering.

Catalogues Received

Walter O. Amsler, of Pittsburg, Pa., has published a catalogue illustrating and describing the Amsler Gas Producer. This catalogue is replete with information of value to engineers; full details are given as to arrangement, relative value of fuels, and the results that may be achieved with this apparatus.

The American Heat & Power Co., First National Bank building, San Francisco, has issued a folder describing its simplex, water method, oil-burning system for domestic purposes.

Moore & Scott Iron Works, of San Francisco, have issued an attractive catalogue containing description and general data covering their mechanical oil burner system and atomizing oil burner.

The George H. Tay Co. has published a price list of pipe and fittings, including malleable, wrought, and cast iron pipe and soil fittings; black, and extra strong pipe for irrigation, casing, tubing, etc.

The Alberger Pump Co., of New York, has issued catalogue 'D,' describing its centrifugal pumps and steam turbines; characteristic curves and graphic tables are shown, as well as information regarding the application of this apparatus to various engineering conditions.

Lilly & Thurston, Rialto building, San Francisco, have been appointed local agents for the cement gun manufactured by the General Cement Products Co., 30 Church street, New York. An interesting catalogue has been issued showing its application to engineering construction.

Commercial Paragraphs

Moore & Scott Iron Works has been awarded a contract for the installation of their high-pressure oil-burner system on the steamer *Eureka*.

D. C. Tuttle, formerly with the engineering department of the Spring Valley Water Co., has been appointed manager of the machinery department of David Bixler & Co., of San Francisco.

The Wisconsin Engine Co., of Corliss, Wisconsin, announces that it has acquired the United States rights for the manufacture and sale of the Grine-Nelles crude-oil gas producer, formerly owned by the Gas Power Machinery Co. of Los Angeles, California. W. K. Thompson, 705 Union Oil building, Los Angeles, is Western sales manager.

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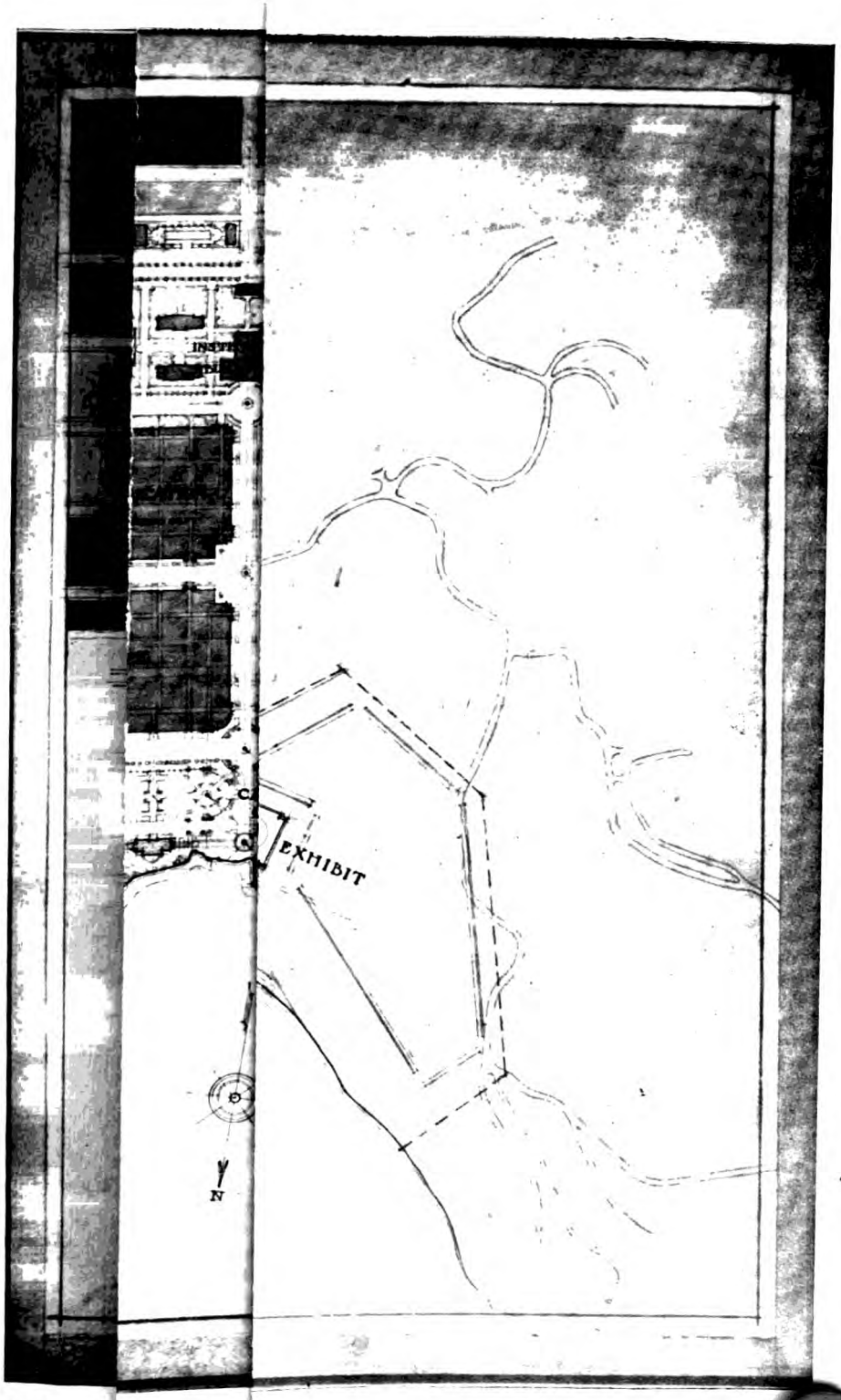

Supplement

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